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In Reply Refer To:
AESO/SE
2-21-02- F-229
2-21-98-F-266

August 23, 2002

James A. Marks, Brigadier General, U.S. Army
Commanding General, U.S. Army Garrison
U.S. Army Intelligence Center and Fort Huachuca
Fort Huachuca, Arizona 85613

Dear General Marks:

This biological opinion responds to your request for consultation with the U.S. Fish and Wildlife Service (Service) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act). Your request for formal consultation was dated July 15, 2002, and received by us on July 19, 2002. At issue are impacts that may result from activities authorized, carried out, or funded by the Department of the Army at and near Fort Huachuca (Fort), Arizona. These activities may affect the following listed species: Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*), southwestern willow flycatcher (*Empidonax traillii extimus*), Mexican spotted owl (*Strix occidentalis lucida*), lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*), Sonora tiger salamander (*Ambystoma tigrinum stebbinsi*), and critical habitat designated for the Mexican spotted owl and the Huachuca water umbel.

This biological opinion was necessary because the 1999 biological opinion (2-21-98-F-266) covering Fort Huachuca was found deficient by the District Court of Arizona on April 11, 2002 (Center for Biological Diversity et al. vs. Donald H. Rumsfeld, Secretary of Defense, et al.; CIV99-203 TUC ACM). The 1999 biological opinion is entirely superceded by this biological opinion.

The Fort requested concurrence from the Service that the proposed action may affect, but is not likely to adversely affect, the spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*), both with designated critical habitat, bald eagle (*Haliaeetus leucocephalus*), jaguar (*Panthera onca*), and Canelo Hills ladies' tresses (*Spiranthes delitescens*). The Service concurs with the Fort's determinations for these species. Rationale for our concurrences is in Appendix 1. We recommend that the Fort maintain a complete administrative record documenting the decision process and supporting information for "no effect determinations.

This biological opinion was prepared using information from the following sources: your July 15, 2002, request for consultation; the July 2002 biological assessment for the project (ENRD 2002); the 1998 biological assessment (BA)(SAIC 1998a); the 1999 biological opinion;

numerous hydrological studies; and our files. References cited in this biological opinion are not a complete bibliography of all references available on the affected species, nor is it a complete review of the effects of military activities on these species. A complete administrative record of this consultation is on file in our office.

Note that this opinion is intended to provide comprehensive compliance with section 7 of the Act for most or all Army activities at and near Fort Huachuca. However, aspects of the Fort's activities not described in the "Description of the Proposed Action and not evaluated in the "Effects of the Proposed Action are not covered by this opinion.

Because of the length and complexity of this opinion, a Table of Contents is included on the following pages.

TABLE OF CONTENTS

CONSULTATION HISTORY

The lesser long-nosed bat, listed in 1988, was the first listed species known to commonly occur at Fort Huachuca. Since that listing, the Service and the Army have conducted section 7 consultation on numerous projects at Fort Huachuca (Appendix 2). Consultations are listed chronologically, from most recent to oldest, and only documents issued by the Service are described. Most of the consultations were informal. All formal consultations were non-jeopardy biological opinions (Appendix 2).

From 1988 to 1993, consultation on listed/proposed species was often combined with review of National Environmental Policy Act (NEPA) compliance documents. Since 1993, consultations have often taken the form of concurrences by the Service on determinations by the Army that their activities would not affect, or would not adversely affect listed species. As more species were listed in the area (Mexican spotted owl 1993; southwestern willow flycatcher 1995; Huachuca water umbel, Sonora tiger salamander, and Canelo Hills ladies'-tresses 1997), the need for consultation grew. The need for a programmatic consultation on all military activities authorized by Fort Huachuca was recognized as early as mid-1989; however, as consultation workloads increased, this need became greater and clearer.

Work began on development of a programmatic biological assessment in 1995. This process culminated in a draft programmatic biological assessment in August 1997 and a final document (SAIC 1998a) in March 1998. This programmatic biological assessment led to the first programmatic biological opinion (USFWS 1999a). However, on April 11, 2002, the biological opinion was found to be arbitrary and capricious and contrary to law by the U.S. District Court of Arizona (CIV99-203 TUC ACM) and was vacated. Therefore, Fort Huachuca required a new biological opinion to document their compliance with the Endangered Species Act.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The action evaluated in this opinion includes ongoing and planned military operations and activities at or near Fort Huachuca (Figure 1), including the airspace currently used by the Fort, for 10 years from the date of this opinion. The time-frame of 10 years was chosen because that is how long implementation of the proposed conservation measures that address use of groundwater are expected to take. Also, we need a specified period of time during which the proposed action will occur to analyze what the effects of the proposed action will be. In addition to military training and operations, the proposed action also includes programmed facilities development projects, recreation, resource management such as fire suppression and prescribed fire, public use areas and restrictions, and wildlife and fisheries management on the installation. This section concludes with summary descriptions of operations and activities that occur in, or are programmed for, training areas across the installation. This section incorporates the proposed conservation measures, which Fort Huachuca intends to implement as part of the proposed action. The information here comes from the Fort's 2002 biological assessment

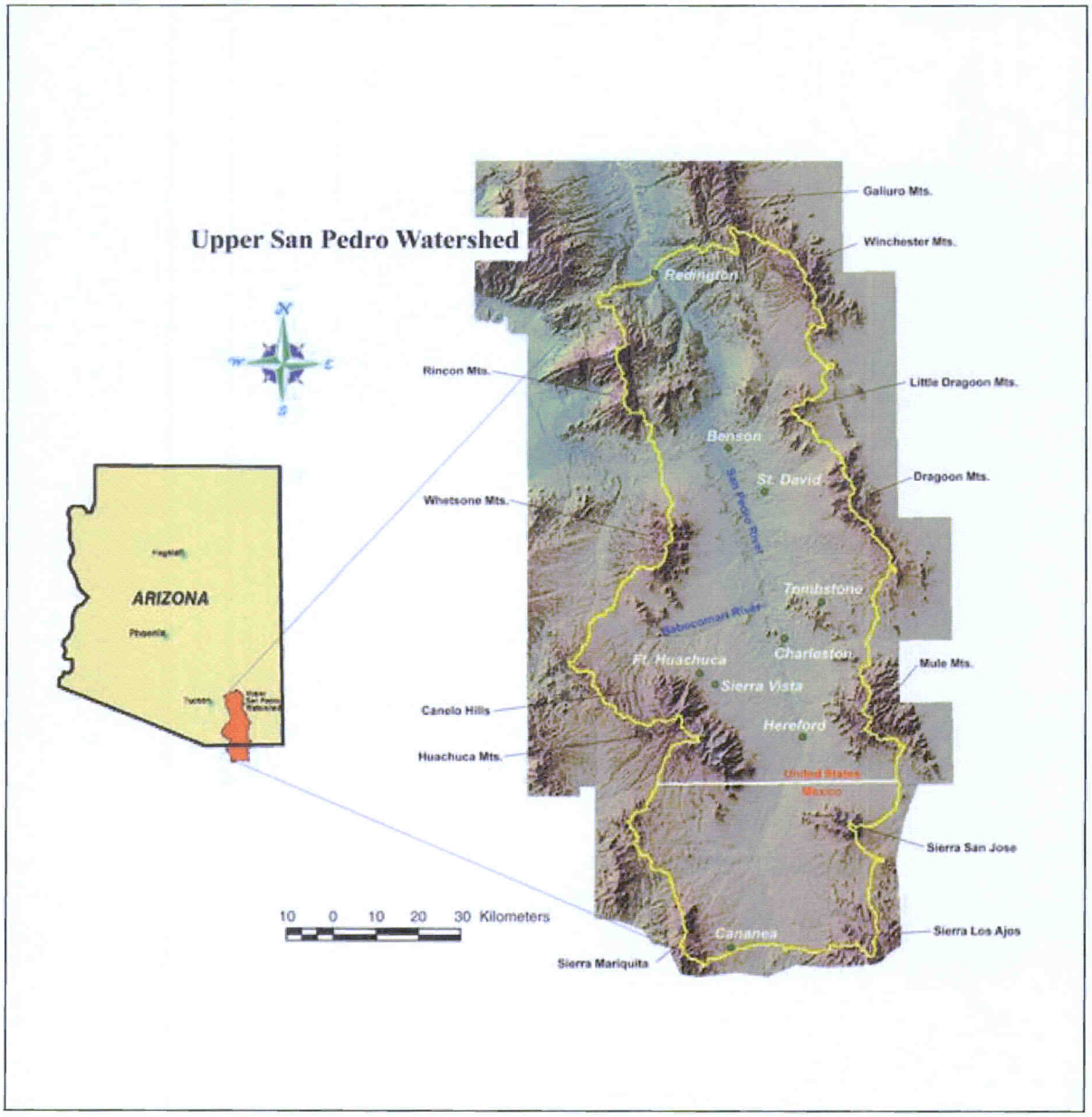

Figure 1. Location of Fort Huachuca, Arizona, and the upper San Pedro River basin, Arizona and Sonora.

(ENRD 2002), the first programmatic biological opinion (USFWS 1999a), and Fort Huachuca's 1998 BA (SAIC 1998a).

Location and Setting

Fort Huachuca contains 73,272 acres west of the San Pedro River and the City of Sierra Vista in Cochise County, Arizona, about 75 miles southeast of Tucson and eight miles north of Mexico. The Fort includes semidesert grasslands and Chihuahuan desertscrub on the bajada at the base of the Huachuca Mountains, as well as the forested east slope of the Huachuca Mountains from about Tinker Canyon on the south to the northern end of the range. For a more thorough description of the action area refer to the biological assessment (ENRD 2002) and the upper San Pedro River Basin report (BLM 1998).

Military Operations, Activities, and Missions

The ongoing missions and activities at Fort Huachuca constitute the operational baseline. The operations, missions, and activities previously discussed in Fort Huachuca's 1998 BA (SAIC 1998a) are incorporated here by reference. Additional activities and missions have occurred since the preparation of those documents and are included in the operational baseline for purposes of this BO. These include the establishment of a regional Civilian Personnel Operations Center (CPOC) at Fort Huachuca and its recent expansion (Environmental Assessments [EA] in 1997 and 2001 [DIS 2001b]); Expansion of Unmanned Aerial Vehicle (UAV) Testing and Training (Directorate of Installation Support [DIS] 2000); Artificial Aquifer Recharge Projects (ENRD 2001a); Purchase of Conservation Easements (DIS 2001a); and installation of a Bergey wind turbine.

This section also includes several proposed actions for which NEPA analysis is either completed or in progress, but for which decisions to implement have not been made. These projects include: a proposed increase in student population at the Military Intelligence (MI) Center (ENRD 2001c), the expansion of Humor drop zone for Missouri Air National Guard training, the installation of improved air surveillance radar, establishment of a Department of Defense (DOD) training center, construction and operation of an Army and Air Force Exchange Service (AAFES) mini-mall (EA in draft), establishment of 9th Army Signal Command/Network Enterprise Technology Command (ASC/NETCOM)(EA being staffed), and the Real Property Master Plan for Electronic Proving Ground (EPG)(EA draft March 2002).

Intelligence and communications systems testing and training activities account for nearly 95 percent of training range use (USAIC & FH 1997). Other supported activities on the installation include field training exercises, aviation activities, live-fire qualification and training, vehicle maneuver training, and administrative and support activities. Each operational activity is discussed in further detail below.

Fort Huachuca is one of 16 U.S. Army installations under the command and control of the U.S. Army Training and Doctrine Command (TRADOC). In October 2002, Fort Huachuca's higher headquarters for garrison operations will be the Installation Management Agency, with regional headquarters at Fort Sam Houston. Fort Huachuca remains the Headquarters for the US Army Intelligence Center (USAIC). It is also the headquarters for the US Army Signal Command (USASC). In October 2002, the USASC will change to become the 9th ASC/NETCOM. This is

discussed in detail below. The Garrison Commander and principal training staff are currently integrated into the USAIC Headquarters Command, designated USAIC & FH. Major missions assigned to the installation exist to:

research, develop, test, and evaluate concepts, doctrine, materials, and equipment in the areas of intelligence, electronic warfare, and information systems;

develop, conduct, and evaluate training in intelligence, electronic warfare, and information systems;

provide trained operational forces in the areas of intelligence and communications;

operate, manage, and defend the Army's information operations and infrastructure;

perform aviation operations; and

provide training opportunities for Active Duty, Reserve, and National Guard Forces.

Military Operations and Training

Fort Huachuca is divided into three training ranges (South, West, and East) and a cantonment area. Each of the three ranges are further subdivided into training areas. A total of 26 training areas occur on the three ranges (Figure 2). The operational baseline at Fort Huachuca is comprised almost entirely of intelligence and communications systems, research, development, testing, and training; these activities account for nearly 95 percent of training range use. Other military activities on the installation include field training exercises, aviation, small arms qualification and training, vehicle maneuver training, and administrative and support activities.

Military Intelligence Training

Fort Huachuca provides MI training to over 2,500 students annually. An EA was prepared in December 2001 to support expanding the Army's training base. To date, this action has not occurred but it is incorporated as part of the proposed action.

Intelligence and Communication Systems

The majority of operational testing and training at Fort Huachuca are related to intelligence and communications systems. Units are engaged in the development and testing of various types of electronic equipment (see Appendix B of BA). These units are also involved in training soldiers in the use of this equipment in classrooms and field exercises (USAIC & FH 1992, USAIC & FH 1993b).

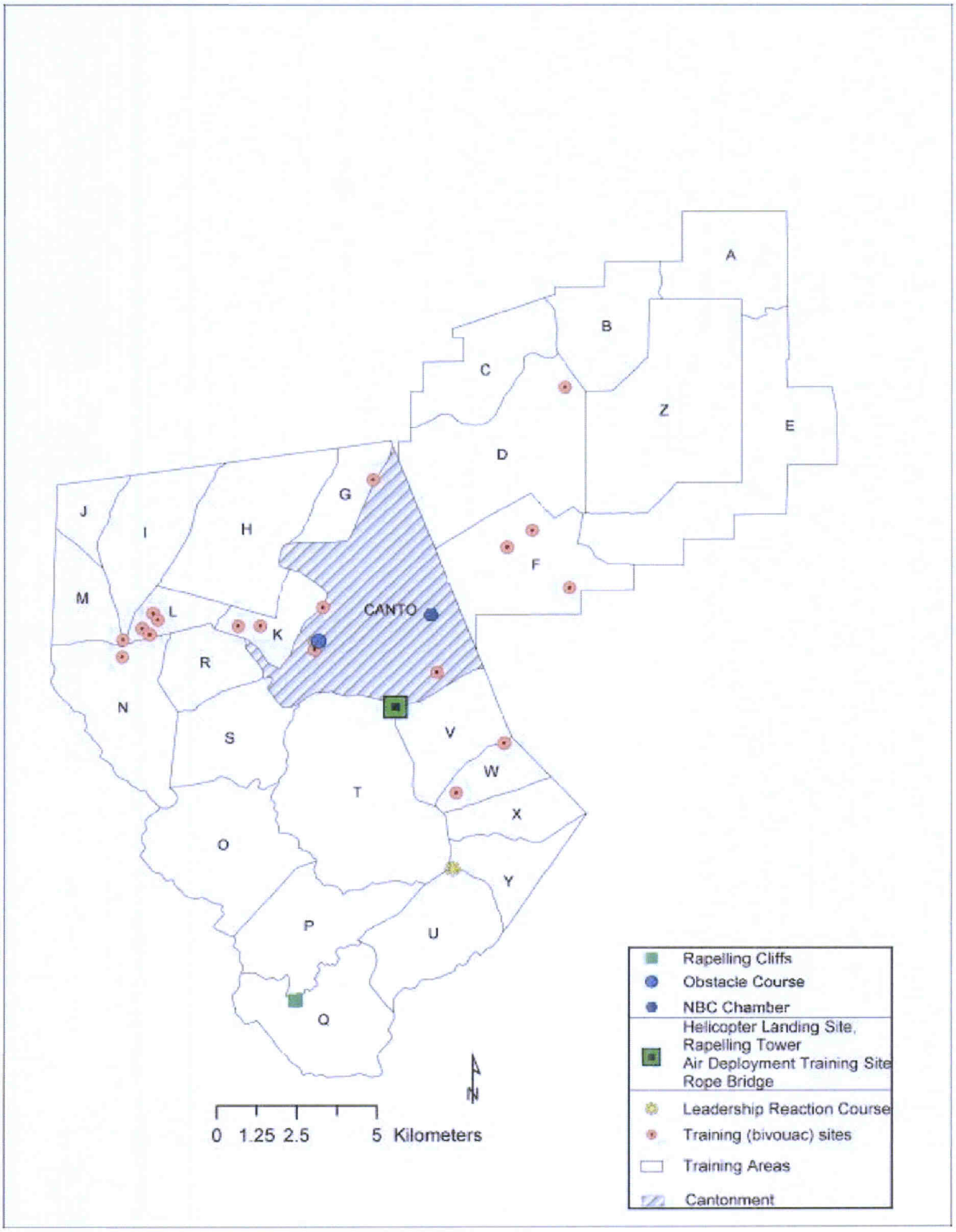

Figure 2. Fort Huachuca, Arizona, training areas and facilities.

Management, Operation, and Defense of Army Information Systems

USASC will be taking on additional responsibilities for the management, operation, and defense of all Army Information Systems. In October 2002, it will transition to 9th ASC/NETCOM which involves hiring up to 130 persons over the next several years. This activity is included in the operational baseline.

Intelligence and Electronic Warfare Equipment Training and Testing

A major mission at Fort Huachuca is the testing of intelligence and electronic warfare equipment and training of soldiers on intelligence operating procedures requiring realistic placement of intelligence systems globally. Equipment is stationed at various Army Security Agency (ASA) sites across the installation and off-post to test the capability of electronic systems to operate under a variety of geographic and atmospheric conditions (USAIC & FH 1992, USAIC & FH 1993b). These sites constitute a network of about 2,400 on-post and 675 off-post markers (Figures 3 and 4). Training and testing is conducted by dispatching intelligence and electronic warfare equipment to a selection of ASA sites that meet the requirements for training to be conducted. On-post sites are located across the installation along existing roads and trails in previously disturbed areas. Off-post sites are usually located within the road right-of-way shoulders along several highways in Cochise and Santa Cruz counties. The remaining off-post sites are located in previously disturbed areas.

At the time of training, vehicles and personnel can be deployed to any combination of ASA sites but most remain on Fort Huachuca. Training sites generally consist of one to two vehicles with four to six support personnel and up to 20 students. On rare occasions, training activities can be as large as 20 vehicles, 50 support personnel, and 70 students (USAIC & FH 1992, USAIC & FH 1993b). Types of equipment include electronic, computer, or radar imaging systems. The vehicles involved can consist of five-ton trucks, heavy duty four-wheel drive vehicles, and very infrequently, tracked vehicles. These vehicles are either equipped with an electronic equipment shelter or used to transport soldier-transported systems and operators. These vehicles are driven to the site and parked in predetermined areas while operations are underway. No off-road vehicle travel outside previously established parking areas or designated sites is authorized. Vehicles must either remain on established roads or trails or can park adjacent to the road or trail in a previously disturbed, designated area at each ASA site. Tracked vehicle movement is not authorized outside of the installation and is confined to existing roads and trails in training areas Bravo, Charlie, Delta, and Foxtrot (B, C, D, and E on Figure 2) on the East Range. Tracked vehicles are sometimes used outside the installation, but on these occasions they are transported to the site on trailers. If necessary for the test, they are off loaded and remain stationary. They never maneuver outside the installation.

Several types of transmitting antennae are used, from small vehicle or system mounted whip antennae, to ground mounted antennae that can be raised to a height of 65-80 feet. At each site, antennae(s) may be erected consisting of driving metal or wooden stakes into the ground 12 to 18 inches for the attachment of guy wires. Most exercises last for no more than 10 to 11 days with 18 daily hours of operation, but activities may last as long as 90 days (USAIC & FH 1992,

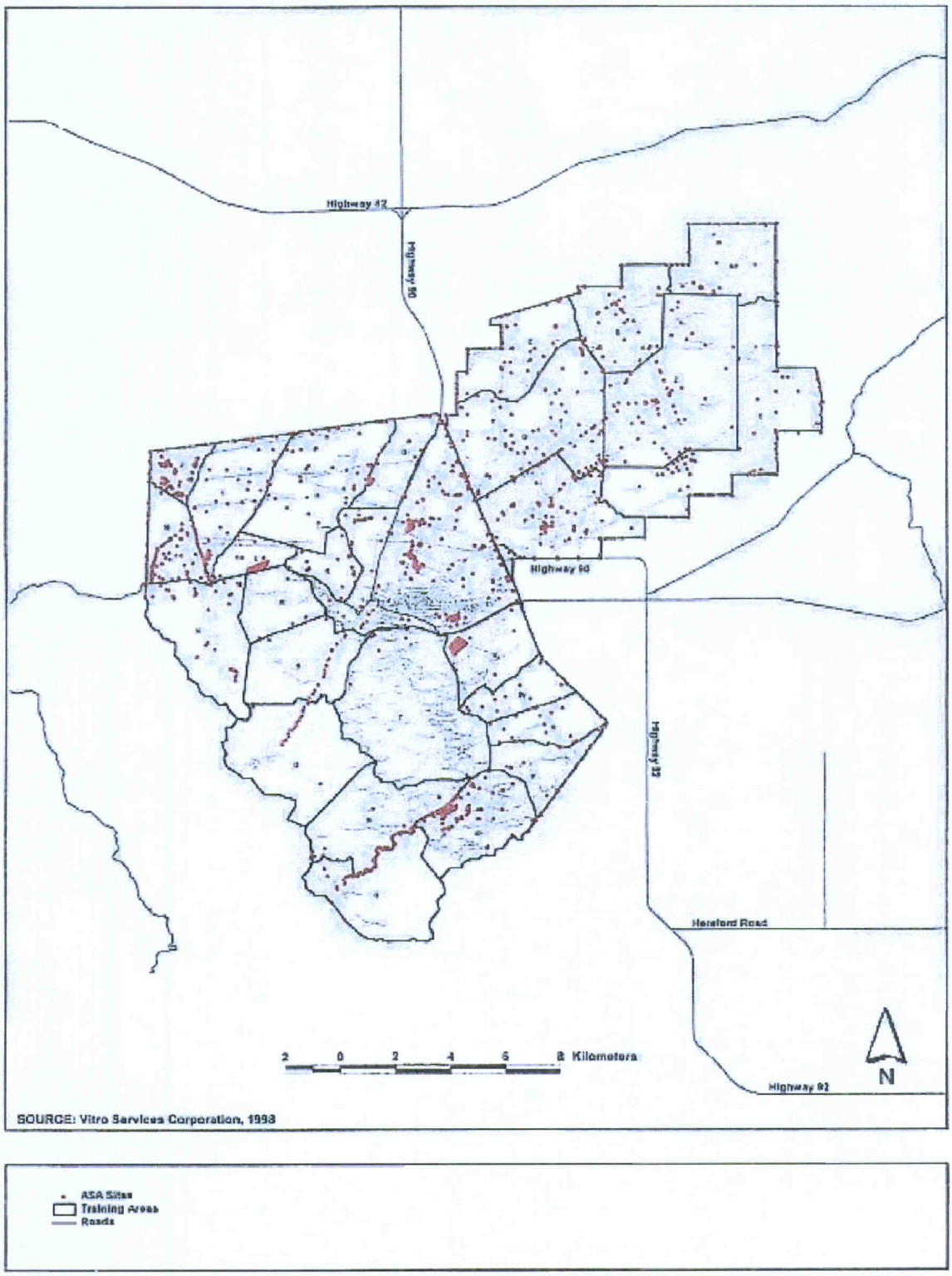

Figure 3. Army Security Agency training sites on Fort Huachuca, Arizona.

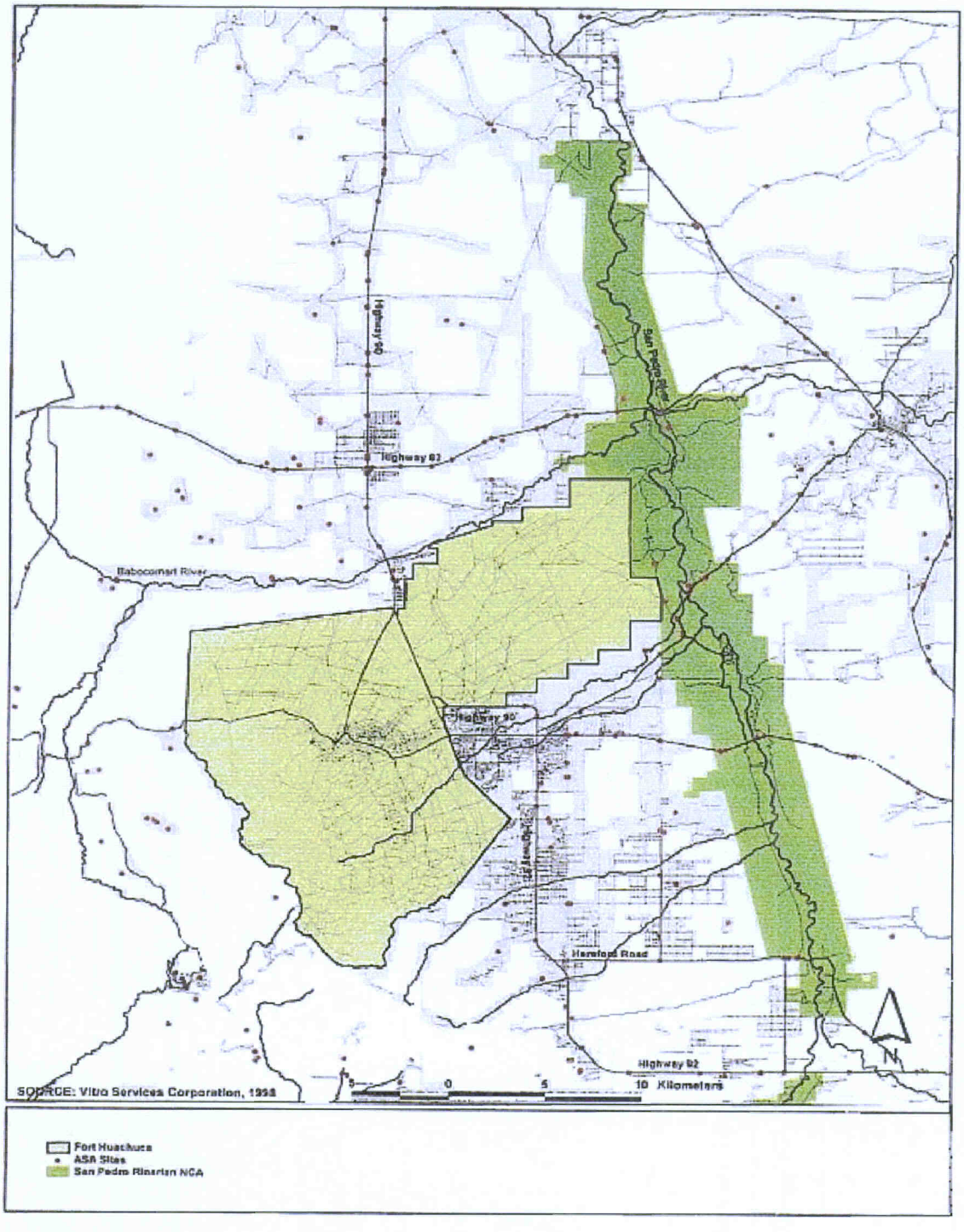

Figure 4. Army Security Agency sites outside of Fort Huachuca, Cochise and Santa Cruz Counties, Arizona.

USAIC & FH 1993b). On occasion, some training can require groups of students to conduct limited dismounted exercises during day and night operations. This training can require 30 to 50 students to walk cross-country to other predetermined locations or ASA sites. Training sites located in or near protected agave management areas found in training areas Lima, Mike, and portions of Hotel, India, Romeo, Tango, Victor, Whiskey, X-Ray, and Yankee adhere to special use restrictions. These restrictions stipulate that:

> no firing of blanks or pyrotechnics will occur within 0.25 mile of protected agave management areas;
>
> training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment; and
>
> night operations are prohibited from July 1 to October 31 in protected agave management areas.

Military trainers and civilian testers who fail to comply with these measures of protection may lose their privilege to train or test in these areas at the discretion of the Range Control Officer (ENRD 1997).

Communications Systems Training and Testing

Another major mission at Fort Huachuca involves radio systems training and testing. Portable equipment is moved on military five and two ton vehicles pulling a wide variety of generators, antennae, and trailers. During training, vehicles and personnel are deployed to a variety of preexisting sites across the installation. Typical exercises last from 7 to 14 days with 24 hour operations. Each field unit may utilize about 40 to 80 vehicles, 50 generators, 12 communications shelters, and 80 to 100 soldiers per site, but generally as little as 3 vehicles and 9 soldiers at each relay site (USAIC & FH 1992, USAIC & FH 1993b). The maximum area covered by a unit during training is about 40 acres with 13 remote site locations per exercise. Large bivouac exercises occur in predefined areas used repeatedly for such activities with relay sites located across the installation. Predefined bivouac areas often include permanent structures and concrete pads for repeated bivouac establishment. Remote relay sites are located all across the installation. Sites selected for use across the installation must be approved by Range Control before use. Range Control may restrict the use of certain areas during high fire potential seasons and enforce the previously-discussed special regulations for protected agave areas (see above).

Two types of larger exercises are also conducted, including Battalion and Brigade. Battalion level exercises involve 160 to 200 personnel in which about 20 vehicles are used with 8 to 12 such exercises conducted every year. Brigade level exercises involve 400 to 500 personnel with about 150 to 200 vehicles used in such operations with 1 or 2 such exercises conducted each year. There are no set time lines for testing activities. Tests are conducted year round, and might

last 24 hours per day, seven days per week, for as much as a month. These activities occur at similar sites to those mentioned previously for communications training. Range Control may

restrict the use of certain areas during high fire potential seasons and enforce the previously discussed special restrictions for protected agave areas.

Field Training Exercises

Fort Huachuca is used for training by various Fort Huachuca operational units, Army Reserve and Arizona National Guard units, and Fort Huachuca partner organizations. All training activities requiring use of range facilities are scheduled, coordinated, and controlled through the Installation Range and Training Office. Field training exercises consist of land navigation, patrolling and tactics training, individual development training, and vehicle maneuver training.

On occasion, sites across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Specific bivouac areas vary from exercise to exercise and do not always coincide with existing ASA sites. Use of any site must be requested a minimum of 21 days in advance from Range Control.

No vegetation clearing is authorized during the establishment of a bivouac. Holes can only be dug into the ground with prior permission from Range Control. Concrete pads in some permanent bivouac areas are used for cooking purposes to prevent waste water from seeping to the ground in case of spills.

There are about 18 established bivouac areas on the installation (Figure 2). These sites are used most often for the larger scale communications testing and training activities. These larger bivouac areas (40 acres) are maintained for permanent use to minimize the need for additional large set up areas.

Land Navigation

Land navigation involves the training of personnel to accurately navigate on foot and locate preestablished sites and locations. Land navigation exercises typically involve 15 to 20 personnel and 4 to 5 vehicles for transportation of personnel. Operations generally last from morning until evening and are conducted year round except in protected agave management areas. All vehicles are kept on existing roads and trails. There is no live fire, firing of blanks, or pyrotechnics permitted. There are two existing land navigation courses on the installation:

a course in area Uniform with 44 surveyed concrete points with ASA markers; and

a course in area Mike consisting of 58 surveyed concrete points with ASA markers.

Additional land navigation training is conducted across the installation on the West and South Ranges. This training is similar to that which occurs on Land Navigation Courses. Vehicles are

used to transport personnel and are kept on existing roads, trails, or parking areas at all times. There is no live fire, firing of blanks, or pyrotechnics permitted. Activities are conducted during day and night, except within protected agave management areas where night operations are prohibited from July 1 through October 31.

Patrolling and Tactics Training

Patrolling and tactics training occurs across the South and West ranges. The exercises, which generally last three days, are conducted every month of the year. About 43 personnel are involved in the operations each month. Ammunition used during these operations includes pyrotechnics, smoke, and M16A2 blanks.

In these training exercises, soldiers maneuver on trails and cross-country. They occasionally dig holes about five inches deep to bury sensors near the trails and major roads. All vehicles used during this training are kept on existing roads and trails.

No firing of blanks or pyrotechnics can occur within 0.25 mile of protected agave stands. Firing of blanks is also prohibited if it is determined by Range Control or the Fort Huachuca Fire Chief that a fire hazard exists. Activities are conducted day and night, except within protected agave management areas where night operations are prohibited from July 1 through October 31.

Occasionally, a Special Forces unit will request to conduct patrolling training in the Huachuca Mountains on-post. These exercises usually involve teams of less than 12 personnel. Personnel are provided training on environmental awareness, and are prohibited from making campfires or killing animals during their patrolling training. This type of training may occur once each year at Fort Huachuca.

Individual Development Training

Several permanent, individual development training facilities are located on the South and West Range and within the cantonment area include:

a rappelling tower (Training area Tango);
a rappelling cliff (Training area Quebec) in Garden Canyon;
a rope bridge training site (Training area Victor);
a Leadership Reaction Course (Training area Uniform); and
a Demonstration Hill (Training area Kilo) used to conduct various demonstrations.

These facilities are used to train personnel from a variety of host and partner organizations.

Vehicle Maneuver Training

Vehicle maneuver and driver training activities occur across the installation on existing roads and trails. The majority of vehicle maneuver training consists of wheeled-vehicles with occasional tracked-vehicle training. Wheeled-vehicle training maneuvers can include attaching and detaching trailers, loading and unloading equipment, and driver training across the installation. All maneuvering activities are confined to existing roads and trails.

Oversized vehicles are restricted to roads; whereas light vehicles can use roads and trails. A trail is defined as a route that is maintained periodically. No cross country maneuvering or other use of existing off-road maneuvering lanes occurs or is planned except as described for the Missouri ANG below or emergency situations (safety, fire, etc.). All existing and planned operations will adhere to the following regulations:

> Follow Fort Huachuca Regulation 385-8, Safety - Range and Training Area Operations (1 May 2001);
>
> Follow guidelines set forth in the Installation Spill Contingency Plan - Fort Huachuca, Arizona (20 December 1996); and
>
> Submit Fort Huachuca Form 1155 (Revised 1 August 93) through appropriate channels for approval before commencement of maneuvers which require access to the East Range.

Off-road vehicle travel is not authorized at any location on Fort Huachuca. Training areas Charlie and Delta (East Range) contain the only locations where off-road vehicle use may occur at Fort Huachuca during the life of the project. These locations comprise about 5,172 acres designated for off-road maneuvering lanes. No off-road activity has occurred since 1994 (Figure 5 of BA). The Humor DZ has been expanded and is used for dropping palletized loads from aircraft. This will require about four short off-road recovery trips for each of the 25 classes offered by the Missouri ANG. These would occur in training area Bravo, between the existing Humor DZ and Hubbard landing strip. No other off-road vehicle maneuvers are presently occurring or are planned. If the off-road maneuvering lanes will be used in the future, separate section 7 consultation may be required.

Live Fire Qualification and Training

Most live fire activities take place on weapons qualifications ranges in training area Tango. Maximum ammunition and associated noise levels used on these ranges are listed (Table 1). Locations of these firing ranges and their associated safety fans are provided in Figure 6 of BA. Tracer rounds are permitted on all live firing ranges with the exception of Ranges 2, 3, and 4, when conditions permit.

Table 1. Firing Ranges on Fort Huachuca (Zillgens 1991; ENRD 1997; Miller, pers. com., 2002).

Range	Range Utilization	Maximum Ammo Permitted	Maximum Noise Level at Firing Point[1]
Range 1	Currently inactive	NONE	N/A
Range 2	M-16 Rifle Zero Range with 40 firing points and a target width of 100 meters.	5.56mm	156 dbP
Range 3	Small bore multi-purpose range with 15 firing points, and 75 meters maximum range.	7.62mm	156 dbP
Range 4	Pistol range complex consisting of a competition firing range with 25 firing points and target distances at 25 and 50 meters (Range 4A), and an US Army Standard Pistol Qualification course with four firing points with target distances from 7 to 31 meters (Range 4B).	.45 cal	162 dbP
Range 5	High explosive hand grenade range with 12 firing points. Currently inactive, due to safety considerations.	M67 FRAG (ONLY)	171 dbP
Range 6	50 firing points and 6 firing lines from 100-1,000 yards.	.50 cal	159 dbP
Range 7	Currently inactive	NONE	N/A
Range 8	Automated record fire range with 10 firing points and target distances from 50 to 300 meters.	5.56mm	156 dbP
Range 9	Range 9A serves as a multi-purpose machine gun range with four firing points, Range 9B is used for recoilless rifles.	.50 cal, 106mm	160 dbP
Range 10	M-79 and M-203 grenade launcher range. High Explosive (HE) cannot be fired on this range.	40mm	154 dbP
Range 11	Currently inactive	NONE	N/A
Range 12A	.50 caliber, 7.62mm and 40mm live fire weapons range. HE ammunition cannot be fired on this range.	120mm, .50 cal	160 dbP
Range 12B	Tank gunnery range. HE ammunition cannot be fired on this range.	NONE[2]	N/A
Range 12C	Tank gunnery range. HE ammunition cannot be fired on this range.	NONE[2]	N/A
Range 13	M-16 marksmanship record fire range with 16 firing positions and targets from 50 to 300 meters.	5.56mm	156 dbP
Range 14	Currently inactive Squad attack course	NONE	N/A
Range 15	Currently inactive Platoon attack course	NONE	N/A

[1] Based on impulse noise levels and do not represent steady noise or time-weighted average.
[2] There is no tank gunnery firing currently authorized at Fort Huachuca.

Small Arms

Small arms qualification and live fire at Fort Huachuca occur only on 9 of the 17 existing live fire ranges in training area Tango. Firing ranges are used for personnel qualification and training throughout the year. Live fire does not take place at night on ranges 2, 3, and 4 from July 1 through October 31.

Artillery and Mortar

The East Range contains several surveyed firing points for mortar and artillery firing into impact area Zulu (see Figure 5 of BA). These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the preexisting firing points is required, further section 7 consultation may be required.

Training activities which include use of the East Range for mortar firing are subject to Army regulation and must carry sufficient fire suppression equipment at all times in the event of a fire. Range Control regulations also require observation personnel to maintain constant watch during training activities for accidental fires resulting from mortar use on the East Range.

Administrative and Support Activities

The administrative and support activities performed at Fort Huachuca are those activities associated with the day-to-day operation of the installation and the ranges, inclusive of those activities performed by USAIC & FH, the directorates, and partner organizations. Several administrative and support organizations exist at Fort Huachuca to support the installation's ongoing role as a major Army testing and training installation. Personnel from these organizations are located in the cantonment. They include those personnel associated with the CPOC and its recent expansion.

The U.S. Army Garrison at Fort Huachuca includes the Command Group; Protocol Office; Public Affairs Office; Chaplain Activities Office; Inspector General; Office of the Staff Judge Advocate; Joint Planning Group; Office of the Chief of Military Intelligence; the Directorate of Installation Support (DIS); Resource Management; Public Safety; Programs for Community Activities; Human Resources; Information Management; Contracting; Operations; Training and Doctrine; Evaluation and Standardization; and Combat Developments. The Garrison also includes a Department of Tactics, and Intelligence and Military Science. These offices support more than 40 commands, agencies, and activities which reside across the installation. Each organizational element may contain additional divisions, branches, and sections. The offices and directorates are primarily located within the cantonment area.

AAFES provides support for many of the commercial needs of soldiers and their families. Currently, AAFES provides the following on-post locations for services: Main Post Exchange, Shoppette/Mini Mall with gasoline dispensing, several food service operations, laundry and dry-cleaning services, and Military Clothing Sales. AAFES is proposing to build an additional mini-mall with gasoline dispensing capability near the main gate of Fort Huachuca.

Aviation Activities

Aviation activities at Fort Huachuca include fixed-wing piloted aircraft training, rotary-wing piloted aircraft training, unmanned aerial vehicle (UAV) testing and training, and unmanned drug surveillance balloon operation. Most aviation activities occur at Libby Army Airfield (LAAF), a military-civilian joint-use facility along the northern boundary of the cantonment area. The LAAF supports military aircraft involved in test and training programs, troop movements, and standard military, commercial and private travel operations. Three runways, several taxiways, aprons, and parking areas for fixed and rotary-wing aircraft cover the largest portion of the airfield area. Air operations are sustained by numerous support facilities which include a flight control tower, a navigational aids building and airfield operations building, an airfield fire and rescue station, utilities support structures, and storage buildings. Air space used by UAVs at Fort Huachuca and restricted airspace currently used by the installation is shown in Figure 7 of BA. Flight corridors and other aviation-related training areas at Fort Huachuca include (Figure 8 of BA):

a C-5A aircraft training mock-up (training area Victor);
an emergency helicopter landing area (training area Victor);
helicopter landing areas for proficiency and emergency operations (training areas November, Romeo, India, and Kilo);
the Hubbard Assault Airstrip (training areas Bravo and Delta) - a dirt assault strip/landing zone which can accommodate C-130 aircraft (2,200 x 5,250 feet);
the Hubbard Drop Zone (training areas Charlie and Delta) 2,800 x 5,600 feet;
the Humor Drop Zone (training area Bravo) 2,700 x 5,550 feet (proposed expansion would increase dimensions to 5,900 x 9,900 feet);
the Havoc Drop Zone (training areas Charlie and Delta) 2,800 x 5,600 feet; and
the Hyena Drop Zone (training area Echo) 1,000 x 1,000 feet.

About 70,155 aviation evolutions (each landing or departure counts as one evolution) occurred at LAAF between September 1996 and August 1997 (Scheibe 1997). Military operations included approximately 50,651 evolutions or 72 percent of all activity (of these 50% were jet). General aviation accounted for about 11,015 evolutions or 16 percent of all activity. Commercial air traffic accounted for about 8,489 evolutions or 12 percent of all activity (Scheibe 1997).

Approaches to LAAF are considered Class D Airspace since the facility contains a manned control tower. The airport's airspace includes a horizontal radius of 4.3 statute miles of the airport, extending from the surface up to 7,200 feet mean sea level. Aircraft are not permitted to

enter the airspace until the Air Traffic Control tower is contacted for clearance to do so. During the time the tower is closed, the airspace reverts to Class G, or uncontrolled airspace.

Restricted areas contain airspace identified by an area on the surface of the earth within which the flight of aircraft is subject to restrictions. Four restricted areas, R-2303A, R-2303B, R-2303C, and R-2312, are located near LAAF. Flight operations originating at LAAF (i.e., helicopter and UAV operations) utilize only small portions of this airspace.

Other fixed wing activities at LAAF include tenants at Fort Huachuca, such as the US Forest Service (USFS) air tanker base and the US Border Patrol border surveillance activities. Occasionally, other agencies use LAAF temporarily, including North Atlantic Treaty Organization partner aircraft, transient USAF operational aircraft, and civilian air shows.

Fixed-Wing Piloted Aircraft Training

No military fixed-wing piloted aircraft training activities originate at Fort Huachuca. However, Fort Huachuca authorizes use of airspace and facilities at the installation by other DOD agencies for proficiency testing and training during exercises originating at other installations. The following summary discussions represent aviation activities that use Fort Huachuca airspace or facilities during training or testing operations. The potential effects from these fixed-wing piloted aircraft training activities at LAAF and within Fort Huachuca airspace are evaluated in this biological opinion.

Individual pilot proficiency training for the U.S. Air Force and U.S. Air Force Reserve is conducted in Fort Huachuca airspace and at LAAF facilities. The A-10s averaged 18,885 flight evolutions at LAAF for calendar years 1988 to 1993, for an average of 37 percent of the annual military activity at the airfield (Scheibe 1997). This training consists of low altitude touch-and-goes.

The Arizona Air National Guard (AZ ANG) and Missouri Air National Guard (MO ANG) use Fort Huachuca airspace and LAAF facilities on a continuous basis for individual proficiency training for pilots. The AZ ANG maintains a training center on post for the MO ANG's training course. They have five C130s or C17s at a time, with 25 to 26 training classes a year. The AZ ANG 162nd Fighter Group headquartered in Tucson, uses LAAF for instrument approach procedures, missed approach procedures, instrument departure procedures, and touch-and-go takeoffs and landings (AZANG 1997). The AZ ANG and MO ANG aircraft have used LAAF for an annual average of 21,400 flight evolutions, or approximately 42 percent of the annual military activity at the airfield (Scheibe 1997).

Drop zones (DZ) on the East range and the Hubbard Landing Zone are used by the Arizona and Missouri Guard units as training flight destinations and objectives where actual airdrops or landings can be practiced. The Hubbard Landing Zone provides tactical airlift crews a rare peacetime opportunity to land and takeoff from a dirt runway. The Hubbard Landing Zone is

presently used by each training aircrew for four landings and takeoffs during the class period. Annual operations for the landing zone are about 720 evolutions (AZ ANG 1992). The Missouri Air Guard has recently requested an expansion of the Humor DZ to accommodate air drops of palletized loads. The expansion would increase the size of the DZ to 5,900 x 9900 feet. The Hubbard Landing Zone air zone used during this activity is shown in Figure 8 of BA.

The DOD, in cooperation with the FAA is proposing to replace the current air surveillance radar at Fort Huachuca within the next five years. Several alternatives for the location of the new system are being analyzed, but no decision has been made. Once the locations are narrowed to two or three alternatives, Fort Huachuca will determine the potential effects to federally-listed species and consult with the FWS as appropriate.

Rotary-Wing Aircraft Operation and Training

Most rotary-wing aircraft operations occur at LAAF. On occasion, rotary-wing operation may occur at the various helicopter landing pads across the installation and at the Black Tower UAV complex on the West Range (Figure 8 of BA). Typical rotary-wing aircraft operations originating from Fort Huachuca include departure from LAAF upwards to about 8,500 feet above mean sea level and subsequent cross-country travel throughout Arizona to other destinations. Rotary-wing traffic adheres to existing restricted airspace regulations (Figure 7 of BA). Helicopters are required under Federal Aviation Administration (FAA) regulations to be operated in a safe manner. Three helicopters are currently in operation at Fort Huachuca. They are primarily operated at 3,500 feet above ground level, but may be operated at any elevation that is safe. Joint Task Force 6 helicopters take off and land at Fort Huachuca; JTF6 pilots receive briefings on installation regulations before take off. JTF6 flights occur approximately 20 to 25 days annually and include low-level flights along the Mexico border, but not on Fort Huachuca. There are no low-level rotary-wing aircraft training exercises conducted at Fort Huachuca.

Unmanned Aerial Vehicle Testing and Training

UAVs tend to be large radio-controlled aircraft that have a 20 to 30 foot wingspan and are about as long (USAIC & FH 1993a, AUAVPO 1991). The following activities are part of the proposed action:

> Transfer in 2001 of the Navy's Pioneer UAV to Pensacola, Florida;
> Deployment of the Medium UAV (Shadow) in 2001;
> Upgrade of existing UAV facilities. A new runway with supporting facilities is proposed for the Rugge-Hamilton facility. The Applied Instruction Building would be expanded by 56,000 square feet. Additional facilities would be constructed at Shadow (previously Pioneer). Existing dirt airstrip at Demonstration Hill would be paved and used. LAAF would continue to serve as a UAV test site;
> Construction of new UAV training facilities. There are proposed new facilities at LAAF, East Range, and near existing facilities;

> Increased frequency of testing and flights. Anticipated increase is 30% in airspace R-2303A. Rugge-Hamilton and Shadow are expected to be used 300 flying days per year, 8 hours per day.

The Comprehensive UAV Testing and Training EA (June 2000) provides additional information on these activities.

Fort Huachuca currently supports the operation and training of the Shadow UAV. This UAV has standard flight elevations of 3,500 to 4,000 and 6,500 to 7,000 feet above ground level respectively during testing and training activities. The minimum altitude at which UAVs travel (excluding take off and landing approaches) is 1,000 feet above ground level. UAVs usually operate above the West Range and to the west of Fort Huachuca. Typical flight paths for these UAVs are shown in Figure 7 of the BA. The UAV Training Center on the West Range provides support to the Shadow UAV. This training is conducted at the Advanced Instruction Building, Shadow training complex, and Rugge-Hamilton flight line, about 6 miles west of the cantonment on the West Range. The training center operates on the West Range from approximately 0500 hours to 1600 hours with infrequent night operations. They use equipment such as UAVs, ground control stations, 5-ton trucks, mobile power units, and antennas.

Flight tests involve take off from the Fort Huachuca UAV complex on the West Range and travel westward to the Canelo Hills and Altar Valley target areas. Within the two target areas, surveyed ground points are marked with steel reinforcing rods as potential target vehicle parking spots. During the flight tests, five or six trucks may be positioned within each target area for up to four hours at a time. The target vehicles used are generally two-ton trucks (two each), and four-wheel drive pickup trucks (eight each). No off-road travel by vehicles is authorized. Target vehicles are provided with shovels and fire extinguishers.

Other activities conducted by UAV facilities involve flight tests of UAV systems requiring moving and fixed imagery targets. Such tests are normally conducted both within and outside the Fort boundaries. Typically, the activity is broken into two parts:

> Launch and recovery of the vehicles from training areas India and Juliet (Hubbard and Rugge-Hamilton sites) which does not involve a large number of vehicles or personnel;
>
> Imagery targeting which involves the creation of imagery targets for the UAV's such as command posts, tank personnel, etc.

The activities are located across the East and West ranges at previously determined sites. The number of personnel per target positioning can range from 5 to a maximum of 90. Each unit spends one to two days in each area and then may be replaced by another detachment. The movement of vehicles is confined to existing roads and trails, with some occasional off-road foot traffic. The number of vehicles in an area at a given time is about 18 per exercise. Rocket-assisted takeoffs (RATOs) occur at Shadow and Rugge-Hamilton airstrips. The noise generated

by the takeoff rockets ranges from 76 to 93 dB. Due to the expense of the equipment, RATOs generally occur less than 10 times a year.

Unmanned Drug Surveillance Balloon Operation

In 1987, an AEROSTAT Drug Surveillance Balloon became operational in the southern portion of the South Range. The blimp-type balloon is ground tethered and is an aerial platform for radar equipment used to detect aircraft illegally entering the U.S (Zillgens 1991). It provides radar data for U.S. Customs, the DOD, and the FAA. It operates year round, 24 hours per day, within about 23 acres of training area Y on the South Range. Airspace used for the AEROSTAT balloon is shown in Figure 7 and 8 of the BA. This airspace is restricted for AEROSTAT activities only.

Recreational Activities

Southeastern Arizona is a popular destination for local visitors, as well as international and national travelers. The San Pedro Riparian National Conservation Area (SPRNCA), Kartchner Caverns State Park, the Scenic Railroad, Coronado National Forest, Ramsey Canyon Preserve, Coronado National Memorial, and other unique tourist and recreational attractions increase visitor interest in the area. Current recreational use in the Sierra Vista area is concentrated in areas just outside the Fort such as Ramsey and Carr Canyons and the San Pedro RNCA. Garden, Huachuca, and Scheelite canyons are additional popular recreational sites located within the installation. In 1995, about 30,000 birders visited these canyons (ENRD 2002).

Recreational Activities at Fort Huachuca

Recreational use of Fort Huachuca has increased in recent years along with the general increase in tourism throughout the Cochise County area. Since September 11, 2001, Fort Huachuca has been a closed post with access limited to authorized personnel. At lower threat levels, recreational access is permitted with identification, vehicle registration and proof of insurance and areas outside the firing ranges and impact areas are typically available for recreational activities. The variety of natural and recreational resources in the Fort Huachuca area, especially for bird watching and hiking, suggests that interest in these resources will continue to grow. Popular activities at the Fort include bird watching, hiking, horseback riding, golfing, fishing, and hunting. Recreational activities are unrestricted, but parts of the Fort may be closed to the public during military training activities.

Hunting and Fishing

Many big game species are hunted at Fort Huachuca. Hunters also have the opportunity to hunt three species of quail, two species of dove, and several other small game species. There are 30 hunting management areas on Fort Huachuca (Figures 9 and 10 of BA). Fort Huachuca hunting seasons and bag limits are set in coordination with the Arizona Game and Fish Department.

Hunting and fishing programs are covered by the 2001 Fort Huachuca Integrated Natural Resource Management Plan (INRMP)(ENRD 2001b).

There are 16 ponds (about 32 acres) located on post (Table 2). Seven of these ponds are stocked with trout if water conditions are favorable (Figure 5). Ponds are open to fishing during daylight hours only. Garden Canyon Creek is closed to fishing. The use of salamanders and other live bait is prohibited by the Arizona Game and Fish Department in Cochise County west of the San Pedro River and south of State Highway 82, including Fort Huachuca (Appendix C in BA).

Hiking, Camping, and Sports

There are several camping and picnicking areas on Fort Huachuca. They include:

Lower Garden Canyon picnic area which has 10 sites with tables and grills and is open to self-contained recreation vehicle and tent camping. The area includes a comfort station, playgrounds, and a ramada for protection from the sun and rain.

Middle Garden Canyon picnic area which has picnic tables, grills, a playground, and ramada.

Upper Garden Canyon picnic area which has picnic tables, grills, a playground, and ramada.

Golf Course Pond has 12 picnicking sites with tables, grills, and ramadas. RV camping is permitted and a comfort station and softball field are located on site.

Apache Flats Recreational Vehicle (RV) Park has 50 spaces for RVs with electricity, picnic tables, grills, tenting spaces, and a dump station. Water is available at 50 spaces.

Split Rock cabin is available for rental when fire conditions permit.

Garden Canyon cabin is available for rental when fire conditions permit.

Sportsman Center campground has 24 hookups for RVs, ramadas, picnic tables, and grills.

Garden and Huachuca Canyons offer wooded sites for picnicking away from the main post. Reservoir Hill offers a spectacular view of much of the San Pedro Valley. Camping on post is permitted only in designated campgrounds and mountain areas are accessible only during the day. About 45 miles of hiking trails are available on the Fort. Some of these connect with trails on the Coronado National Forest and provide hiking access to other portions of the Huachuca Mountains.

Recreational rock climbing and rappelling are prohibited. An existing 18-hole golf course serves both military and civilian personnel and is located on the eastern end of the cantonment area just south of the Main Gate to the post. Caving is permitted during certain times of the year. This activity is prohibited during times of lesser long-nosed bat roosting.

Horseback Riding and Grazing

Horses can be rented by the hour or day at the Buffalo Corral Riding Stables, located on the West Gate Road. Boarding of privately owned horses is also available. Three areas are used for grazing horses at Fort Huachuca. These three areas support about 50 to 60 horses. Use of these areas is rotated every 12 to 18 months.

Pasture A is about 946 acres and is used infrequently from May to October. Pasture B is approximately 175 acres and is used between the months of March and May. Pasture C is about 312 acres and divided into two sections with rotation between the two. Horses are grazed in pasture C from May to October. At other times, horses are kept in a corral and the pastures are not grazed. Horseback riding is authorized across the installation with the exception of firing ranges (when in use) and impact areas.

Table 2. Ponds of Fort Huachuca, Arizona.

Pond	Game Management Area	Size (Sq. Acres)	Depth	Stocked[1]
Golf Course	V	5	>14'	Yes
Officers Club	Cantonment	3	>15'	Yes
Gravel Pit	T-2	5	>13'	Yes
Woodcutters	T-3	2.5	>15'	Yes
Fly	T-1	3.25	5'	Yes
Lower Garden	Y	2.5	8'	No
Middle Garden	U	2	8'	No
Sycamore I	H	2.5	15'	Yes
Sycamore II	J	1.75	7'	Yes
Tinker Canyon	U	1	8'	No
Blacktail	N-2	1.5	- -	No
Hidden	I	0.75	2.5'	No
Antelope	I	1.5	2'	No
Laundry Ridge	K	- -	- -	No
Upper Garden	Q	- -	- -	No
Kino	M	- -	- -	No

[1] Ponds are stocked with trout if conditions are favorable but not always annually.

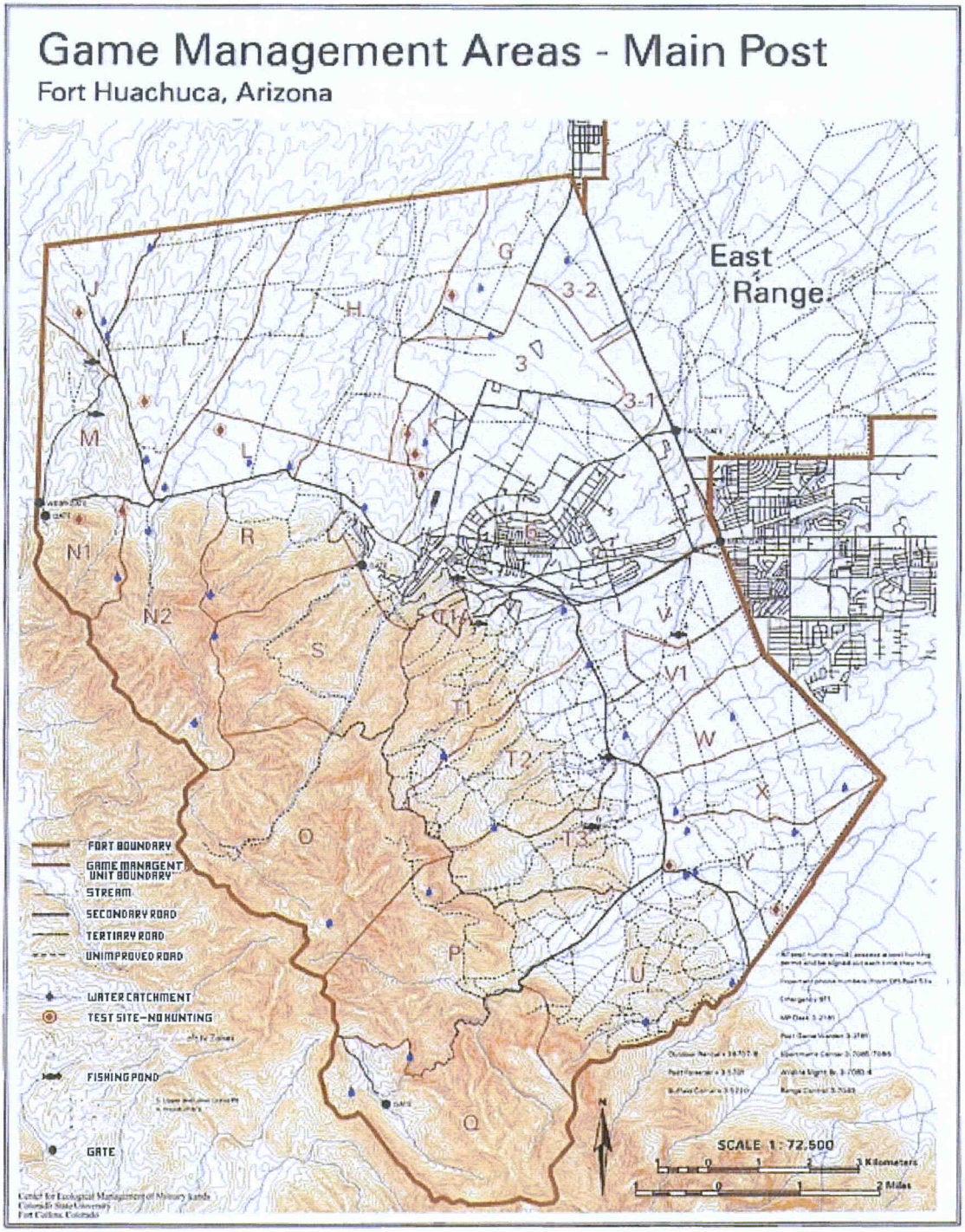

Figure 5. Game management areas and ponds on Fort Huachuca, Arizona.

Integrated Natural Resources Management

Fort Huachuca completed an INRMP in November 2001 (ENRD 2001b). The plan helps guide natural resources management on Fort Huachuca from 2001 to 2005 while supporting Fort Huachuca's military mission. The INRMP is supposed to ensure that natural resource conservation and military activities are integrated and consistent with federal law. The INRMP includes planning for vegetation management, wildland fire management, erosion and nonindigenous species control, recreational management, and inventory and monitoring. The INRMP and all of its components are included here as part of the proposed action.

Fire Management Planning

A fire management plan for Fort Huachuca was drafted by Robinett et al. (1997). As of this writing, the plan has not been adopted in full by Fort Huachuca, but the programmatic guidance for fire planning in that plan is considered part of the proposed action by Fort Huachuca. That guidance, as well as other fire management activities that Fort Huachuca plans to implement are summarized here:

1. Policies to be followed in fire management include:

    a. Protection of life (firefighter and public) is the first priority. Property, military training, and natural and cultural resources (including endangered species protection) are second priority.

    b. Each prescribed fire shall be compatible with approved military training, public safety, or resource management objectives.

    c. The use of prescribed fire shall be considered in establishing the management strategy for all ecosystems, particularly those determined to be partially or totally fire dependent.

    d. Interagency prescribed fire qualification and certification standards will be implemented. A qualified and adequate work force will be trained and maintained to plan and implement managed fire projects safely and effectively. Each prescribed fire shall be conducted by qualified personnel in accordance with Western Region Prescribed Fire Qualification System.

    e. Public health and environmental quality considerations will be incorporated into the use of managed wildland fire.

    f. Once adopted, the Fort Huachuca Fire Management Plan will be reviewed on an annual basis and formally evaluated and reaffirmed every three years. Monitoring results from burns will be used in assessing the plan and making necessary revisions.

g. Fire will be allowed in all areas with burnable vegetation at a reasonable return interval, except where occupied by humans. All areas below Charlie Break will be managed primarily by Fort Huachuca, while areas above Charlie Break will be managed primarily by the Coronado National Forest under a Memorandum of Agreement.

h. Fires occurring in areas of human settlement (i.e., administrative sites, historic structures) will be suppressed immediately.

i. Fort Huachuca fire management policy in military training areas below Charlie Break is one of prescribed burning coupled with control of fires that occur in or near structures or occur in grasslands and savannas outside of prescription. Fires started by tracer fire will be managed to consume fuels throughout the entire Small Arms Impact Range Area in a safe, prescribed manner.

j. US Forest Service and Fort Huachuca policy for woodlands and forests above Charlie Break allows for unplanned ignitions and management-ignited prescribed burning, as well as suppression (confine, contain, control) when appropriate. (Charlie Break runs roughly from the junction of Training Areas N, R, and S southeast to a point on the south boundary of Training Area U (Figure 6).

2. Prescribed (natural or ignited) fire shall be managed in accordance with the following guidelines. Implementation of prescribed fire will be contingent upon compatibility with military training, availability of funding and resources, and occurrence of correct burning conditions.

a. For each prescribed fire, Fort Huachuca will develop a prescribed burn plan that will include a description of the burn area, burn objectives, public safety issues, protection of sensitive features, range of expected results, weather and fuel conditions needed to achieve the desired fire behavior, containment procedures, pre-burn coordination (e.g., with the Service and the Coronado National Forest), monitoring plan, smoke management plan, and contingency plan.

b. The goals of prescribed burns on Fort Huachuca include: i) reducing fuel loads in military training areas to reduce catastrophic fires, ii) maintaining or improving wildlife habitat, including improving pronghorn range away from firing ranges to reduce their foraging in burns near firing ranges, iii) reducing the risk of catastrophic fires in habitats used by threatened and endangered and candidate species, iv) decreasing the likelihood of major fires in upper elevations that can cause an increase in erosion and decrease in water infiltration and recharge of aquifers, v) reestablishing the natural frequency and intensity of fires that would sustain flora and fauna biodiversity of Fort Huachuca, vi) reducing the potential for fire to spread into the Fort's urban interface areas, and vii) minimizing the threat of fire to the Fort's historical buildings and archeological sites.

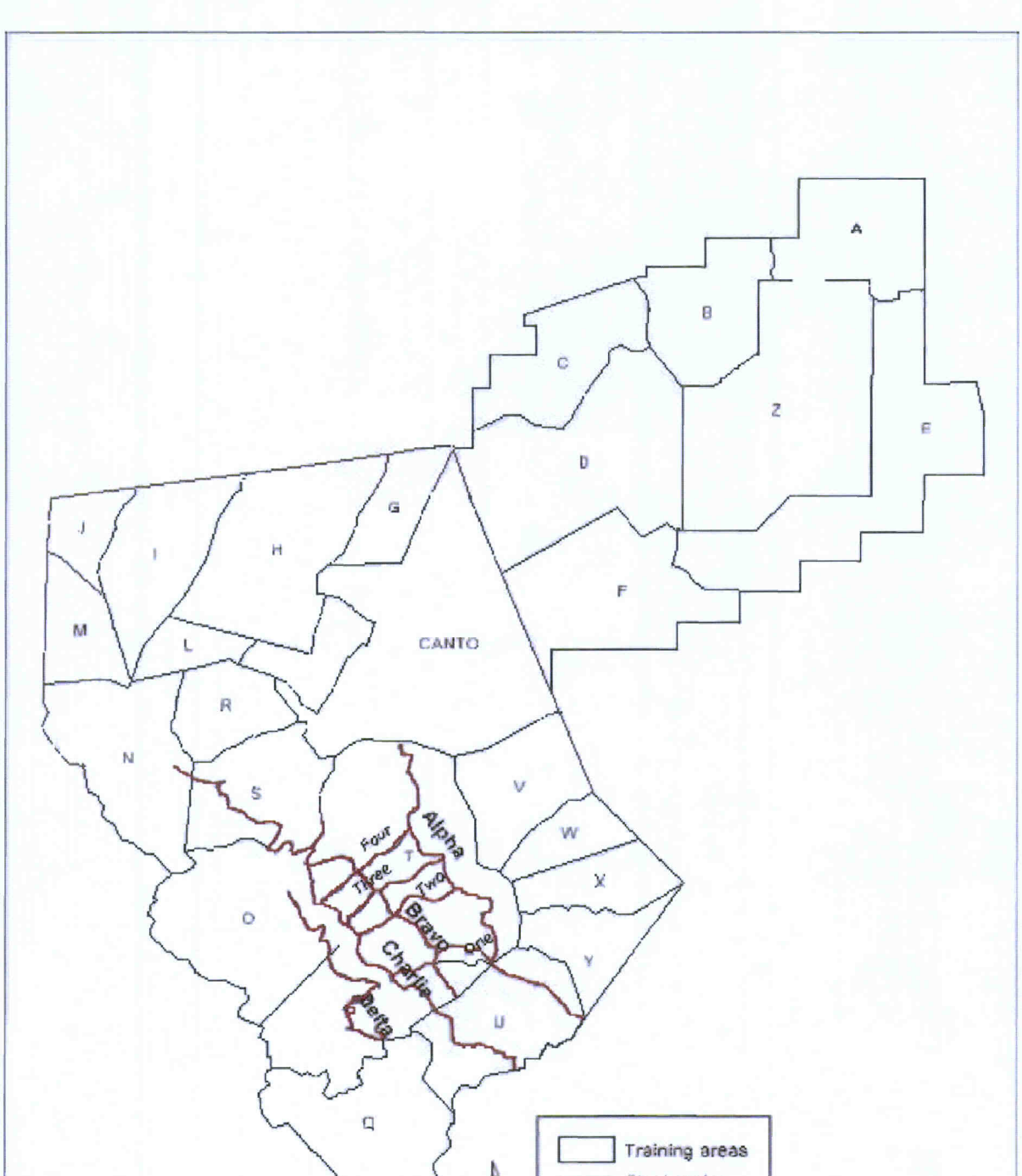

Figure 6. Main fire breaks on the South Ranges of Fort Huachuca, Arizona.

c. Average fire return intervals should reflect the intervals of the natural fire cycle. Burn intervals in grassland, oak savanna, and pine-fir woodlands should average 5 to 10 years. Burn intervals will vary, but intervals shorter or longer than the average will be appropriate in some areas to meet management or military training objectives. Fire intervals in agave management areas shall be once every 10 to 15 years.

3. Subject to available funding and resources, the Fort will take action to reduce woody fuels above Charlie Break. Fuel reduction could be accomplished by mechanical means, such as pruning, thinning; as well as prescribed fire.

4. Once adopted and incorporated into the INRMP, Fort Huachuca will implement the Fire Management Plan to address suppression needs and prescribed fire. The plan will include guidelines related to resource personnel responsibilities, adjacent landowner responsibilities, fuels management, climatic monitoring, prescribed burning, smoke management, firebreaks, pre-suppression, and training, research, and equipment needs.

5. Post-wide wildfire suppression activities will include the following five fire management measures to prevent fires and aggressively control wildfires if they occur:

a. Provision of fire suppression trucks on-site during live fire exercises when deemed necessary by the Range Control Officer and Fort Huachuca Fire Department;

b. Maintenance of required firebreaks;

c. Avoiding firing activities during high hazard conditions, such as strong winds;

d. Avoiding the use of tracers during high to extreme fire danger periods;

e. To reduce the potential for adverse effects of fire suppression measures on listed and candidate species and their habitat, a biologist or other qualified environmental specialist will be available to serve as a resource advisor to provide guidance to individuals in charge of fire suppression activities.

Realty Actions

Fort Huachuca has the authority to exchange, acquire, or dispose of lands to benefit their mission. Currently only one realty action is planned, although others may be proposed during the life of the project. The Fort proposes to exchange a 26-acre parcel near Kayetan Drive and Buffalo Soldier Trail to the Arizona State Land Department for state in holdings on the East Range. This exchange was authorized by special state legislation in 1987. A related land exchange is also being planned to gain full title to several parcels of land on the East Range. In cooperation with the Bureau of Land Management (U.S. BLM) and the State of Arizona, state trust lands may be exchanged to ensure that full title to those parcels is conveyed to the federal government.

The City of Sierra Vista seeks to acquire from Fort Huachuca 203 acres next to LAAF under the Airport Improvement Act (Appendix D in BA). The land would be for aviation-related uses. If this realty action is proposed in the future, it will undergo a separate section 7 consultation.

Energy Initiatives

Fort Huachuca has installed one Bergey wind turbine on the West Range and wind data collection equipment on the South Range. There is one data tower now; an additional 11 towers may be installed as discussed in the August 2001 consultation. Under current economic conditions, no further installation of wind turbines is proposed.

Electrical privatization is required by a Secretary of the Army initiative. Currently, Fort Huachuca purchases electricity from Tucson Electric Power as delivered to the main substation near Greely Hall. Operation and maintenance of the Fort's distribution system are performed for the government under contract with All Star. Under this initiative, the Fort's distribution system would be turned over to a private contractor. Electrical rate to the contractor would include purchased power and operation and maintenance of the distribution system. Fort Huachuca is in the process of soliciting this service and expects completion by 2004.

Privatization of the natural gas distribution system, water production and distribution system, and wastewater collection and treatment system are also Secretary of the Army initiatives. These are still in the planning stages.

Fort Huachuca currently has other alternative and renewable energy projects in place (photovoltaic, fuel cell, Dish/Stirling [solar]). These are small scale and there may be similar projects installed. Medium and large scale power sources (photovoltaic, Dish/Stirling, Solar Chimney/Biomass, and co generation have been mentioned. Economic feasibility and funding availability are uncertain; these projects are not included in the proposed action.

Programmed Facilities Development

Programmed renovation and construction of facilities development projects support mission-related activities. Army projects programmed for construction within the current planning cycle are listed in Table 3. These new military construction projects will occur within the cantonment and within compatible land use areas. Facilities development projects include several military construction army projects targeted for construction and several physical upgrades or improvements to existing buildings.

Cantonment Area

The cantonment area and other developed lands cover about 5,720, or eight percent of the installation. The majority of the 1,899 buildings and structures on the installation are located within the main cantonment area. The cantonment area provides a variety of operational and testing facilities, maintenance and production facilities, research, development test and

Table 3. Proposed long-Range MCA and Operation and Maintenance Army (OMA) Projects Listing (FY 02-14) at Fort Huachuca.

FY	Project Description	Project No.	Scope	Unit of Measure	Funding[1]
02	Effluent Reuse & Recharge/P2	46756	- -	- -	MCA
02	WNR Pershing Plaza West - P1	31434	75	Units	MCA/AFH
03	WNR Pershing Plaza West - P2 (P/S only)	54403	75	Units	MCA/AFH
04	WNR Pershing Plaza West - P3 (P/S only)	54404	77	Units	MCA/AFH
06	Bowling Center Upgrade (P/S)(A/C - Elec. Upgrade)	43410	- -	- -	NAF
06	RV Park Expansion (P/S only)	53018	100	Spaces	NAF
06	Barracks with Battalion (P/S only)	38675	224795	SF	MCA
06	UAV Training Facility (P/S only)	55205	24540	SF	MCA
06	Chapel	50198	19940	SF	MCA
06	Global Information (P/S only)	55241	83250	SF	MCA
06	Vehicle Maintenance Facility	01388	21600	SF	MCA
07	Electronic Maintenance Facility (P/S only)	47283	50507	SF	MCA
07	Test & Evaluation Facility (P/S only)	53342	41220	SF	MCA
07	Youth Center Addition	33321	5332	SF	MCA
07	Community Club (P/S only)	45970	10000	SF	NAF
07	Sportsman Center (P/S only)	45969	10000	SF	NAF
07	Water Tank Potable (P/S only)	54561	.6m	GAL	MCA
07	Running Track (P/S only)	52128	5280	LF	MCA
07	Buffalo Corral Upgrade	45972	- -	- -	NAF
07	Pershing Plaza E/1 (P/S only)	31430A	75	Units	MCA/AFH
08	Aircraft Fuel Storage (P/S only)	46513	458000	GAL	MCA
08	Airfield Fence (P/S only)	44768	36800	LF	MCA
08	Pershing Plaza E/2 (P/S only)	31430B	77	Units	MCA/AFH
09	Chapel (Ed) (P/S only)	46484	16455	SF	MCA
10	Pershing Plaza E/3 (P/S only)	31430C	75	Units	MCA/AFH
10	Roads Paved (P/S only)	28561	- -	LF	MCA
10	Cavalry Park / #6 & Signal Village #1	42752	56	Units	MCA/AFH
11	Ammunition Supply Point (P/S only)	11708	25163	SF	MCA
11	Miles Manor 1 & 2 (P/S only)	31432	46	Units	MCA/AFH
12	Christy Sewer (P/S only awaiting funds	48149	- -	- -	OMA
12	Combined Sewers areas 5 & 6 (P/S only awaiting funds	48327	- -	- -	OMA
13	Army Continuing Ed Services Bldg- P/S only	56208	- -	- -	MCA
13	Combined Sewers areas 3&4 - P/S awaiting funds	53291	- -	- -	OMA
14	Main Gate Access Bldg (Being Programmed)	58605	8600	SF	MCA
14	East Gate Access Bldg (Being Programmed)	58603	5600	SF	MCA

[1] MCA = Military Construction Army AFH = Army Family Housing LN = Lane
NAF = Non-Appropriated Fund SF = Square Feet FA = Family Unit EA = Each

evaluation, supply facilities, hospital and medical facilities, administrative facilities, housing and community facilities, and utility and ground improvements, housing and community support services, as well as administrative and operational directorates and training facilities. Major command headquarters are located throughout the cantonment area as well as maintenance and storage facilities, facilities for research, development and testing, medical care, and training. Within the cantonment and other built-up areas, land management activities and maintenance fall under the direction of the DIS.

Fort Huachuca maintains and operates a number of facilities and conducts activities associated with operating a military installation. These include: 1) operation and maintenance of a 3.1 million gallons per day capacity wastewater treatment plant; 2) collection of solid waste, and disposal primarily at the Huachuca City landfill, but some material goes to the Elfrida landfill; 3) a recycling program for paper, aluminum cans, and newspaper that produced 527.8 tons in 2001; 4) a network of roads, most of which are primary or collector streets in the cantonment area, and many unpaved routes on the training ranges; 5) operation of three gates to the installation; 6) distribution and use of electricity supplied by Tucson Electric Power Company (101,115,000 kilowatt hours in FY 2001; 7) distribution and use of stationary fuels, such as natural gas furnished by Southwest Gas Company and propane; 8) distribution, storage and use of vehicle and aircraft fuels; and 9) operation of a Hazardous Material Center.

The following outdoor training facilities are located within the cantonment area: an obstacle course; a confidence course; and Libby Army Airfield located in the northernmost corner of the Cantonment area. This airfield consists of a 12,000 foot Class 'B' main runway on an east-west axis, a 5,365 foot secondary runway on a southeast-northwest axis, and a 4,300 foot tertiary runway running parallel to the main runway. Maintenance facilities and the City of Sierra Vista air terminal are on the north side of the airfield.

Training Area Activities

This section describes each of the training areas on the installation and the activities conducted in the areas. Information sources from the BA include interviews with the Range Control Officer, Air Traffic Control (ATC) and Air Operations Personnel, annual range utilization surveys, and a supplemental study on training area utilization (SAIC 1997). This section discusses the infrastructure and facilities in the training areas, the military operations, and the recreational use of each training area. Table 4 provides a listing of individual training areas and the type of traffic (both on-road and off-road) permitted in each area.

Action and restrictions common to most training areas, unless specified otherwise, are: they are used primarily for intelligence and communications training and testing activities; wheeled vehicles are only permitted on existing routes in the area; and no off-road vehicle use is permitted. Training areas located in protected agave management areas adhere to special use restrictions:

Table 4. Terrain type and traffic permitted by training area, Fort Huachuca, Arizona.

Training Area	Location by	Total Acres	Terrain Type	Traffic Permitted On Existing Road and Trails	Traffic Permitted Off Existing Roads and Trails
Alpha	East	2471	High Desert	Foot/Wheel	Foot
Bravo	East	2471	High Desert	Foot/Wheel/Tracked	Foot/Wheel
Charlie	East	2100	High Desert	Foot/Wheel/Tracked	Foot/Wheel/Tracked [1]
Delta	East	4694	High Desert	Foot/Wheel/Tracked	Foot/Wheel/Tracked [1]
Echo	East	4942	High Desert	Foot/Wheel	Foot
Foxtrot	East	3583	High Desert	Foot/Wheel/Tracked	Foot
Golf	West	1087	High Desert	Foot/Wheel	Foot
Hotel	West	4200	High Desert	Foot/Wheel	Foot
India	West	2223	High Desert	Foot/Wheel	Foot
Juliet	West	1111	High Desert	Foot/Wheel	Foot
Kilo	West	1136	High Desert	Foot/Wheel	Foot
Lima	West	840	High Desert	Foot/Wheel	Foot
Mike	West	1087	High Desert	Foot/Wheel	Foot
November	West	3410	Mountain	Foot/Wheel	Foot
Oscar	South	2619	Mountain	Foot/Wheel	Foot
Papa	South	3459	Mountain	Foot/Wheel	Foot
Quebec	South	2347	Mountain	Foot/Wheel	Foot
Romeo	West	1359	Mountain	Foot/Wheel	Foot
Sierra	South	2322	Mountain	Foot/Wheel	Foot
Tango	South	5312	Mountain	Foot/Wheel	Foot
Uniform	South	2347	Mountain	Foot/Wheel	Foot
Victor	South	1599	High Desert	Foot/Wheel	Foot
Whiskey	South	1482	High Desert	Foot/Wheel	Foot
X-Ray	South	1235	High Desert	Foot/Wheel	Foot
Yankee	South	1482	High Desert	Foot/Wheel	Foot
Zulu	East	6954	High Desert	Foot/Wheel	Foot

[1] Off-road wheeled and tracked-vehicle traffic is restricted to existing off-road maneuvering lanes. These lanes are currently inactive and have no programmed use. Any such future use of these lanes is subject to NEPA documentation and USFWS consultation before any scheduled use. As of this time, there is no authorized off-road activity in these lanes.

No firing of blanks or pyrotechnics within 0.25 mile of these areas;

Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment;

Night operations are prohibited from July through October.

Most of the training areas are open to hunting. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary. Unless specified in the following narrative, training areas are open to hunting.

Training Area A (Alpha)

Training area Alpha is on the East Range and covers 2,471 acres. The area has a high desert terrain. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (see Figure 5 of BA). These points support 60 and 80 mm mortar, and 4.2-in mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, section 7 consultation would be requested.

Training Area B (Bravo)

Training area Bravo covers 2,471 acres and has a high desert terrain. Both tracked and wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is currently permitted, however, some off-road vehicle traffic will be needed for pallet recovery in support of Air National Guard training.

Mortar firing into Area Zulu is permitted upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80 mm mortar, and 4.2-in mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, section 7 consultation would be requested.

On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. The area contains the Humor Drop Zone, a 2,700 by 5,500 feet area of sparse vegetation on the northern half of the training area used for ANG air drops during Army National Guard training maneuvers. Fort Huachuca proposes to expand the DZ to 5,900 by 9,900 feet. A portion of Hubbard Assault Airstrip is located in training area Bravo and comprises a dirt assault strip/landing zone, which can accommodate C-130 aircraft.

Training Area C (Charlie)

Area Charlie, with an area of 2,100 acres, has a high desert terrain. Both tracked and wheeled vehicles are permitted in this area on existing roads and trails.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80 mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, section 7 consultation would be requested.

This area also contains a portion of the approximately 5,172 acres within the East Range where off-road vehicle travel occurred up to 1994. No off-road vehicle activity presently occurs or is planned by Fort Huachuca. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises.

This area contains a portion of Hubbard Drop Zone (2,790 x 5,580 feet) and the majority of Havoc Drop Zone (2,790 x 5,580 feet). These are areas of sparse vegetation on the eastern and southern half of the training area used for air drops during ANG training maneuvers.

Training Area D (Delta)

This area, located between areas Charlie and Foxtrot, covers about 4,694 acres. The area has high desert terrain. Both tracked and wheeled vehicles are permitted in this area on existing roads and trails. This area also contains a portion of the approximately 5,172 acres within the East Range where off-road vehicle travel occurred up to 1994. No off-road vehicle use is proposed.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area has several surveyed firing points for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, section 7 consultation would be requested.

This area contains part of the Hubbard Assault Airstrip which is a dirt assault strip and landing zone that can accommodate C-130 aircraft (2,130 x 5,250 feet). The area also contains a portion of Hubbard Drop Zone (2,790 x 5,580 feet) and a small part of Havoc Drop Zone (2,790 x 5,580 feet). These are areas of sparse vegetation on the northern edge of the training area used for air drops during ANG training maneuvers. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises.

Training Area E (Echo)

At 4,942 acres, training area Echo is the largest East Range training area. The area has a high desert terrain. Mortar firing into Area Zulu is permitted upon approval from Range Control.

This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, section 7 consultation would be requested.

The area contains Hyena Drop Zone (980 x 980 feet). This area of sparse vegetation in the central portion of the training area is used for air drops during Air National Guard training maneuvers. The area also contains a dirt runway. On occasion, locations across the area are used by training units for setting up bivouacs for the execution of field training exercises.

Training Area (F) Foxtrot

Training area Foxtrot, located between areas Charlie and Echo, is 3,583 acres. The area has a higher level of military activity than other training areas on the East Range. Located to the east of Libby Airfield, air space over portions of this area is located within landing and departure zones of primary runways (Figure 8 of BA). On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises.

Mortar firing into Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, section 7 consultation would be requested.

Area Foxtrot is divided into two game management areas, F1 and F2. Area F2 is closed to all hunting while area F1 can only be hunted with shotgun or bow and arrow.

Training Area G (Golf)

Part of the West Range, training area Golf is about 1,087 acres of high desert terrain. Air space over portions of this area is located within landing and departure zones of secondary runways at Libby Airfield. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises.

Training Area H (Hotel)

Training area Hotel is approximately 4,200 acres and contains protected agave management areas. Air space over portions of this area is located within landing and departure zones of

primary runways at Libby Airfield. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Portions of the installation grazing lands are located in this area.

Training Area I (India)

Training area India on the West Range has a land area of 2,223 acres. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. A helicopter landing pad is located within this area. Patrolling and tactics training is conducted in this area. Testing and training sites located in protected agave management areas within this training area adhere to the special use restrictions. Antelope and Hidden ponds are located in the area.

Training Area J (Juliet)

Training area Juliet on the West Range covers 1,111 acres. In addition to intelligence and communications training and testing activities, UAV operations occur here as do patrol and tactics training. The Black Tower Joint Services UAV Training Complex is located in area Juliet. This consists of a permanent block of structures, temporary trailers, and buildings encompassing the Shadow Training Facility and runway, paved Rugge-Hamilton UAV runway, and the Advanced Instruction Building. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. The Sycamore II pond is located in the area.

Training Area K (Kilo)

Training area Kilo covers an area of 1,136 acres on the West Range. Patrolling and tactics training is conducted in this area. This area contains Demonstration Hill and one Helicopter Landing Area for proficiency and emergency operations. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises.

Portions of the installation grazing lands are located in this area. The Laundry Ridge pond is also located in this area.

Training Area L (Lima)

Training area Lima covers 840 acres and has a large percentage of its land under protected agave management. Patrolling and land maneuvering training are conducted in this area. On occasion,

locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. One large (40 acres) permanent bivouac site is located in the area. This site is about 6,600 feet from an Agave Management Area.

Training Area M (Mike)

Training area Mike covers an area of 1,087 acres on the West Range. Patrolling and tactics training are conducted in this area. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions found above. Kino and Sycamore I ponds are located in the area.

On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. One large (40 acres) permanent bivouac site is located in the area. This site is about 1,650 feet from the Agave Management Area. A land navigation course in training area Mike consists of 58 surveyed concrete points with ASA markers.

Training Area N (November)

Training area November with an area of 3,410 acres consists of mountainous terrain. Military activities in the area are restricted to the relatively flat areas only. Patrolling and tactics training are conducted in this area.

On occasion, sites across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. This area contains one Helicopter Landing Area for proficiency and emergency operations.

For the purpose of game management, the area is divided into two parts, N1 and N2. Blacktail pond is located in N-2 Game Management Area.

Training Area O (Oscar)

Training area Oscar covers 2,619 acres and is part of the South Range. As the terrain of the area is mountainous, the military activities in the area are restricted to the relatively flat areas only. Patrolling and tactics training are conducted in this area. Occasionally, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises.

Training area Oscar is among the areas most heavily used by recreationists. The Huachuca Canyon picnic area is located in the northern part of this area.

Training Area P (Papa)

Training area Papa covers an area of 3,459 acres and is a part of the South Range. As the general terrain of the area is mountainous, the military activities in the area are restricted to the relatively flat areas only. Patrolling and tactics training are conducted in this area. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

The topography of the area contributes to the heavy use of the area by recreationists. Three picnic areas are located in the Garden Canyon area. Facilities in these recreation areas include play areas, grills, and ramadas. There are numerous hiking and horse back riding trails in this area. Recreational users are prohibited from rock climbing and rappelling.

Training Area Q (Quebec)

Training area Quebec covers an area of 2,347 acres and is a part of the South Range. As the general terrain of the area is mountainous, the infrequent military activities in the area are restricted to the relatively flat areas and roads only.

The topography of the area contributes to the heavy use of the area by recreationists. There are numerous hiking and horse back riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Upper Garden Canyon Pond is located in this area.

Training Area R (Romeo)

Training area Romeo is part of the west range and has a land area of 1,359 acres. Patrolling and tactics training is conducted in this area. On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Testing and training sites located in protected agave management areas within this training area adhere to special use restrictions found above. This area contains one Helicopter Landing Area for proficiency and emergency operations.

Training Area S (Sierra)

Training area Sierra is part of the South Range and has a land area of 2,322 acres. Patrolling and tactics training are conducted in this area. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises.

The topography of the area contributes to the heavy use of the area by recreationists. There are numerous hiking and horse back riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Split Rock cabin is located in this area.

Training Area T (Tango)

Located south of the Cantonment, Tango has an area of 5,312 acres. There are 17 live fire ranges in Tango. See Table 1 for range descriptions and the types of weapons used and Figure 6 of BA for locations of firing ranges. Training area Tango is used for personnel development training by almost all units on the installation. This area is a small arms impact area and although no explosive munitions are used, testing and training is not permitted in this area.

The area is divided into three game management areas (T1-3). The area is used for hiking, hunting, and fishing. Gravel Pit, Woodcutters, and Fly ponds are located in this area.

Training Area U (Uniform)

Training area Uniform is part of the South Range and has an area of 2,347 acres. Patrolling and tactics training are conducted in this area. A land navigation course is located on area Uniform. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. This area has protected agave management areas.

The area is also popular for its recreational facilities. Picnic areas are located in this portion of Garden Canyon. The area is used for hiking, hunting and fishing. Middle Garden Canyon and Tinker ponds are located in this area.

Training Area V (Victor)

Training area Victor covers a land area of 1,599 acres and has a desert type terrain. Patrolling and tactics training are conducted in this area. On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. This area contains one Helicopter Landing Area for proficiency and emergency operations.

The area is divided into two subsections (V and V1) for game management. Area V has a golf course and the Golf Course pond; hunting is not permitted in Area V.

Training Area W (Whiskey)

Training area Whiskey covers a land area of 1,482 acres and has a desert type terrain. Large Brigade-level exercises are conducted at Site Boston. The 86th Signal Battalion conducts two

Battalion level and one Brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the Battalion level training, 42 are used at the Brigade level training. Activities during these training include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens. Patrolling and tactics training is conducted in this area. This area has protected agave management areas.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. The area is also used for hiking and hunting.

Training Area X (X-Ray)

Training area X-Ray covers 1,235 acres and has a desert type terrain. Patrolling and tactics training are conducted in this area. Testing and training sites located in protected agave management areas within this training area adhere to the special use restrictions found above.

Large Brigade-level exercises are conducted in this area. The 86th Signal Battalion conducts two Battalion level and one Brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the Battalion level training, 42 are used at the Brigade level training. Activities during these training include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens.

On occasion, locations across the area are utilized by training units for setting up bivouacs for the execution of field training exercises. The area is also used for hiking and hunting.

Training Area Y (Yankee)

Training area Yankee covers a land area of 1,482 acres and has a desert type terrain. Patrolling and tactics training are conducted in this area.

Large Brigade-level exercises are conducted in this area. The 86th Signal Battalion conducts two Battalion level and one Brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the Battalion level training, 42 are used at the Brigade level training. Activities during these training include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises.

The AEROSTAT operations facility and tethered balloon is located in this area. Lower Garden Canyon pond is in this area.

Impact Area Z (Zulu)

Impact area Zulu, also known as the Impact Zone, is a part of the East Range. This 6,954 acre area contains various types of targets for artillery and mortars. High explosive ammunition may be fired on this area. Some areas may contain unexploded ordnance. Range Control Operations has declared off-road areas in this zone permanently "off-limits to recreational activities and warning signs are posted in the area to alert visitors and troops.

This area is sometimes used for intelligence and communications training and testing activities. ASA sites are located along existing roads and trails in this area and can be used for intelligence and communications testing and training. No recreation or hunting is permitted in this area.

Off-Post Activities Authorized or Carried Out by Fort Huachuca

The Fort leases, for military training purposes, about 2,600 acres from a variety of land owners, primarily in southeastern Arizona (Appendix E in BA). An additional 27,387 acres on the Willcox Playa, Cochise County, is withdrawn from public entry. Parcels leased vary in size from less than an acre to 1,280 acres on Willcox Playa, Cochise County. Although most leased or withdrawn land is in Cochise County, the Fort also leases land near Phoenix, Gila Bend, Oatman, Mount Graham, and Mount Lemmon, Arizona; Lordsburg, New Mexico; and Mt. Diablo, California. Many are ASA sites or communications sites (antennas, microwave towers, etc.). Others are pull-off sites along roadways where equipment is temporarily operated. Uses of each site are described in Appendix E in the BA. Many of the equipment tests and field training exercises conducted by a variety of training units at Fort Huachuca require placement of equipment over a large geographic area.

The largest leases or withdrawals are in the Willcox Playa, where Fort Huachuca controls 27,387 acres. The entire site is fenced and closed to public entry. The Electronic Proving Ground has a Radar Geometric Fidelity Test Facility on the floor of the playa. The playa is also used for conducting other classified military electronic and communications equipment tests, which involve using a number of ASA sites on the playa. In 1965, the Fort authorized construction of the Radar Geology Test area on the playa for the National Aeronautics and Space Administration in support of the lunar landing program. The facility is still in place, but is no longer used.

Conservation Measures

The Fort has invested in a broad range of initiatives that are providing water savings. Fort Huachuca has reduced its on-post water consumption by almost 45% since 1993 i.e., from

more the 3,000 AF annually to 1,655 AF in 2001. As part of this proposed action, Fort Huachuca commits to do more.

There are 64,655 people in the Sierra Vista subwatershed. Of the total population in the Sierra Vista subwatershed, 34,993 people (54%) are related to Fort Huachuca as direct, indirect, interrelated and interdependent population. This includes 26,531 military, civilian employees, contractors, military retirees, survivors and family members. It also includes 7,093 induced employees and their family members; their off post groundwater pumping would not occur "but for" the presence of the Fort. Finally, it includes an increase of 1,369 projected Fort personnel, their family members, and induced population growth.

The Fort applies the same 54 percent of the population in the Sierra Vista subwatershed to determine its share of the 5,144 AF groundwater deficit. In this case, 54 percent of the groundwater deficit in the Sierra Vista subwatershed equals 2,784 AF. This is the amount of the groundwater deficit attributable to the Fort's presence in the Sierra Vista subwatershed. This includes all direct, indirect, interrelated and interdependent effects associated with pumping groundwater.

Fort Huachuca calculates that it is responsible for 54 percent of the 5,144 AF groundwater deficit in the Sierra Vista subwatershed, or 2,784 AF based on its direct, indirect, interrelated, and interdependent effects. As part of the proposed action, Fort Huachuca commits to reducing its contribution to the ground water overdraft in the Sierra Vista Subwatershed to zero by the year 2011. Conservation measures that Fort Huachuca will implement to offset its water consumption include conservation savings (437 AF), conservation easements (1,600 AF), and storm water recharge (1,040 AF). The conservation measures proposed by the Fort total 3,077 AF. Therefore Fort Huachuca has committed to mitigate for a greater part of the deficit than what is attributable to them. The proposed 3,077 AF is actually 60 percent of the current estimated deficit. Fort Huachuca proposes to accomplish these goals within the above time frames through construction projects, realty procurements, conservation initiatives, and additionally, through participation in the USPP.

Fort Huachuca's actions will not eliminate the ground water deficit in the subwatershed. The additional current groundwater deficit not attributable to Fort Huachuca is 2,067 AF. Moreover, the projected population increase of 12,931 people would result in a net increase of 1,239 AF of additional groundwater use in the Sierra Vista Subwatershed by 2011. Assuming the population projections are correct, and if no actions are taken to address water issues in the subwatershed other than the Fort's actions, the total cumulative groundwater deficit by 2011 will be about 3,306 AF.

What follows is a detailed description of the conservation measures that Fort Huachuca will implement, the timeline for their implementation, and the amount of net water usage that each

conservation measure/project will save. Several of the conservation measures listed have been implemented, while other conservation measures are in various stages of development or completion.

Water Related Conservation Measures

Fort Huachuca proposes to reduce its on-post water use by 437 AF (Table 5). Water meters at the Fort's wells will measure and report annually the reduction to the Service.

Current water conservation measures include active enforcement of an installation-wide irrigation policy, closure of the Quartermaster laundry, education and the Energy Smart and Water Wise programs, installation of waterless urinals in Post facilities, water harvesting, closure and demolition of aged facilities, installation of horizontal axis washing machines at student dorms and troop billets, low-flow fixtures, leak detection devices and monitoring, replacement of water intensive evaporative cooling systems on individual residences with air conditioning, xeriscaping and desertscaping throughout the Post, and the closure of garden plots.

Fort Huachuca recently completed Phase I of its Army Water Resource Management Plan (AWRMP) and Phase II will be completed in December 2002. Water savings identified and proposed to be implemented in the AWRMP are reflected in the projected pumping analysis (Appendix M in BA). Fort Huachuca expects actions identified in the AWRMP will achieve net water conservation of 437 AF by implementing the projects in Table 5.

Table 5. Proposed water conservation savings projects on Fort Huachuca, Arizona.

Project	Calendar Year Implementation	Estimated Savings
Horizontal Axis Washers	2002 - 2003	30 AF
Xeriscaping	2002 - 2006	5 AF
residential greywater	2003 - 2010	120 AF
barracks/transient greywater	2002 - 2011	160 AF
Replace Evap with AC	2002 - 2011	114 AF
Rooftop Capture	2004 - 2011	100 AF
Irrigation with Effluent	2004	116 AF
	Gross Conservation Savings	645 AF
	Less Projected Mission Needs	208 AF[1]
	Net Conservation Savings	**437 AF**

[1] This estimated additional groundwater pumping is associated with personnel on Fort Huachuca to meet increased mission requirements in communications and training. An additional 500 personnel are included in the proposed action.

Effluent Reuse

This conservation measure is proposed to reduce Fort Huachuca's groundwater pumpage by 116 AF. Fort Huachuca has used treated effluent to irrigate its community golf course and the Chaffee Parade Field for over 30 years. The annual effluent required for these activities varies depending on rainfall and weather. From 1995 to 2000, the amount of effluent used to irrigate the Fort's community golf course was 437 AF annually. More recently, effluent use at the golf course has declined. In Calendar Year 2001, 350 AF of effluent was used to irrigate the Fort's community golf course and 12 AF of effluent was used to irrigate the Chaffee Parade Field.

Fort Huachuca Community Golf Course

Fort Huachuca has evaluated ways to reduce effluent and water use at its community golf course. The Army proposes to upgrade the Fort's community golf course irrigation system, to reduce the annual effluent use. The existing irrigation system is more than 20 years old and has limited flexibility. The Army proposes to install a state-of-the-art, computer-operated irrigation system that is expected to save 30 to 35 percent (105-123 AF) of effluent over the current irrigation system. Conservatively estimating increased irrigation efficiency at 30 percent results in the golf course using 245 AF of effluent. The irrigation system upgrade is scheduled to begin in Fiscal Year 2003.

Phase II of Effluent Recharge and Reuse Project

Another conservation measure Fort Huachuca proposes is to construct Phase II of the Effluent Recharge and Reuse Project to begin in Fiscal Year 2003. This project will extend the Fort's existing effluent piping system to irrigate athletic fields that are currently watered with groundwater. An additional 116 AF of effluent will be used to irrigate the athletic fields, thus reducing a like amount of groundwater pumping each year. Existing effluent reuse is metered and will be reported annually.

As a result of effluent reuse conservation measures and projects, Fort Huachuca proposes to reduce its groundwater pumpage by 116 AF (Phase II), while its demand for reuse of treated effluent will remain stable at 373 AF (compared to 362 AF now).

Effluent Recharge

As Fort Huachuca's water use decreases, the amount of effluent available for recharge will decline in the future. Fort Huachuca currently recovers about 61 percent of the amount pumped as effluent (total effluent 1,013 AF)(Appendix N). This resulted in an estimated 540 AF of effluent recharge in 2001 as the East Range recharge basins came on line during the year.

However, due to reduced water use, Fort Huachuca anticipates that the amount of effluent available for recharge will gradually decline and then remain fairly stable after the year 2011. As shown in Appendix N of the BA, 435 AF of effluent will be available for recharge in the year 2011. This amount of effluent recharge is already included in the water budget for the Sierra Vista Subwatershed, therefore, it is not included toward the Fort's commitment to reduce its impact to ground water use by 3,077 AF by the year 2011. However, the Fort proposes to continue to meter and monitor effluent recharge through wells at the Effluent Recharge project site. Improvements to the monitoring system are being considered.

To facilitate effluent recharge, Fort Huachuca recently completed construction of Phase I of the Effluent Recharge and Reuse Project. This project included upgrading the Fort's wastewater treatment plant to improve effluent quality, and construction of seven effluent recharge basins and one storm water recharge basin. The basins are located on the East Range of Fort Huachuca, where the effluent holding and evaporation ponds were previously located.

All basins have received treated effluent for recharge and appear to work well. There has been rapid infiltration with little evaporative loss. The basins are designed to recharge up to 1,000 AF of water annually. The storm water basin has sufficient capacity to annually recharge at least 250 AF of urban runoff from the built-up areas of Fort Huachuca, depending on precipitation. Additionally, one of the effluent recharge basins can be converted to accommodate storm water recharge in the event of greater than average precipitation.

Conservation Easements

Fort Huachuca will purchase 1,600 AF in conservation easements by the year 2007. The primary objective of conservation easements is to reduce irrigation or other large sources of water pumping near the San Pedro River. The process typically begins with The Nature Conservancy (TNC) purchasing property from a willing seller for fair market value. This property will normally include irrigation rights or address previously irrigated agriculture activity on the property.

Based on pumping records, Fort Huachuca and the Service will determine the appropriate water savings credit, in AF, that will accrue to the Army upon purchase of the conservation easement. The "credit is then calculated toward mitigation of the total amount of ground water deficit related to the Fort. Deed restrictions are added to the property to reflect the conservation easement, and TNC can resell the property to a private individual or entity or be reimbursed by Fort Huachuca.

The conservation easement will usually include restrictions against agricultural irrigation on the property, or limit the landowner's ability to subdivide the property. Property remains on the tax

rolls, and may be used for residential, commercial, or agricultural land uses consistent with the terms of the conservation easement. Finally the TNC will transfer the conservation easement to the BLM. The BLM is responsible for ensuring compliance with the terms of the easement. Another method of establishing a conservation easement is to purchase the easement from the existing landowner, and add permanent deed restrictions to the property, with the landowner maintaining possession of the property.

All processes are in place to acquire conservation easements and the Army has already purchased the initial conservation easement on a tract (Clinton) near the San Pedro River. Based on irrigation records, Fort Huachuca received credit for 630.8 AF, which will be subtracted from the total pumpage associated with Fort Huachuca. In addition to the elimination of pumping for irrigation purposes near the San Pedro River, the property is located in the area between the San Pedro National Riparian Conservation Area (SPRNCA) and the Huachuca Mountains. This area, near the towns of Palominas and Hereford, is referred to as the "Gap," because of a geographic separation in the boundaries of the SPRNCA. Conservation easements in the Gap are also part of a BLM initiative (Gap-Borderlands) that will contribute to the creation of a wildlife corridor between Mexico, the Huachuca Mountains, and the San Pedro River through purchase of selective conservation easements in that area. Currently, Fort Huachuca seeks to establish water-related conservation easements on properties near the southern end of the SPRNCA, in an effort to maintain groundwater flow to the perennial reach of the river between Hereford and Lewis Springs.

Fort Huachuca proposes to continue to work with the TNC, BLM, Service, and any other willing partners to search for conservation easement opportunities. By 2007, Fort Huachuca anticipates acquiring conservation easements totaling 1,600 AF in water savings credit (includes the 630.8 AF obtained by the Clinton tract conservation easement). One parcel has been purchased by TNC; the easement portion has not been determined but the potential water credit is 500 AF. Six other properties are under consideration which have a potential of 1,104 AF. The total amount water credit associated with conservation easements that have either been purchased or are under consideration is 2,234 AF.

Storm Water Recharge

As an additional water conservation measure, Fort Huachuca proposes to construct storm water retention projects. Fort Huachuca expects to recharge 1,040 AF of storm water into the Sierra Vista Subwatershed. Within the Fort's urbanized area, impermeable surfaces generate several thousand acre-feet of urban runoff that could be available for recharge. Reducing erosion on Fort Huachuca is a conservation measure with the potential for additional recharge.

The proposed structures will only affect small storm flows in small watersheds upstream of the structure. All other storm flows are not altered. Of those small storms, recharge should be

greater than would occur naturally. Most of the proposed recharge facilities are located between the cone of depression and the Babocomari and San Pedro Rivers.

The primary erosion control and storm water recharge efforts will be on the East Range. Measurement of storm water recharge will be based on records maintained for each basin. The method to calculate the storm water recharge savings will be as follows:

> For Graveyard Gulch, Greely Hall, and Hatfield basins, the following procedure will be used. Fort Huachuca will measure the height of water from measuring devices located in each basin. This will be done weekly after rainfall events and recorded. The Fort will then determine the total volume of storm water (in AF) based on the surface area of each basin. Evaporative losses (depending on month and basin infiltration rates) will then be subtracted. This net amount is the amount of storm water recharge savings for which Fort Huachuca would receive credit to offset groundwater use attributable to the Fort's presence. Structures designed and constructed after those facilities will include weirs for more accurate measurement.

Water Mitigation Policy

Fort Huachuca established a water mitigation policy to identify mission growth and assist in reducing Fort Huachuca's net water consumption. The Fort requires new activities to fund projects or portions of projects that offset any increased water use associated with their proposed actions. This mitigation policy allows Fort Huachuca to track mission growth and to achieve the water saving goals outlined in the conservation measures described above.

The Fort's water mitigation policy is an important conservation measure and funding mechanism because it requires all tenants, agencies, and activities to mitigate water use associated with their proposed action. Below are important parts of this conservation measure, which are quoted from the policy:

1. To comply with the ESA, and allow for mission requirements, any organization increasing its overall personnel strength in the Fort Huachuca area must mitigate the water use associated with these additional personnel and their family members. This mitigation policy also applies to contract employees who work on the installation.

2. Each employee authorization adds direct, indirect, and interrelated and interdependent water usage for them, their families, and within the community. Mitigation will be assessed based on increases from the organization's personnel baseline on 30 September 2001, as reflected in the installation post population planning report.

Table 6 provides information concerning proposed or completed storm water projects and the amount of estimated annual recharge associated with each project.

Table 6. Proposed or completed stormwater projects on Fort Huachuca, Arizona, and amount of estimated annual recharge.

Project	Status	Estimated Annual Savings
East Range Phase I Stormwater Recharge Basin	Completed 2002	150 AF[1]
Graveyard Gulch Retention Basing	Under Const. 2002	110 AF[2]
Hatfield Retention Basin Ph I	Design 2002[3]	10 AF
Soldier Creek Retention Basing	Design 2003	150 AF
Hatfield Retention Basin Ph II	Design 2003	10 AF
Phase III E Range	Design 2005	150 AF
Hatfield Retention Basin Ph III	Design 2005	10 AF
Phase IV E Range	Design 2007	150 AF
Phase V E Range	Design 2009	150 AF
West Range	Design 2009	150 AF
	Total Storm Water Recharge Savings	**1040 AF**

[1] Storm water basin is designed to recharge 250 AF; a conservative estimate of 150 AF is used pending validation in 2002 and 2003. Additionally, one of the effluent recharge basins can be converted to accommodate storm water recharge if precipitation is greater than average.

[2] Method utilized for estimating the recharge for Graveyard Gulch was based on watershed area, average distribution of rainfall events, area of basin, and infiltration rates of soils. This data was developed during the design process. Specific data was not available for the other basins listed because design is not completed. The East range estimates are based on similarity to Graveyard Gulch.

[3] Typically, projects will be designed one year before construction.

3. Mitigation for large increases in personnel (over 30 personnel associated with a single project or action), to include civilian contractors who work on post, will occur before the personnel increase or hiring action. Otherwise the mitigation fee will be paid by the organization with personnel growth when the annual 30 September post population report is issued. Mitigation may be accomplished by the gaining organization in at least two ways. Either method must be coordinated through the

Environmental and Natural Resources Division (ENRD), Directorate of Installation Support (DIS).

a. The first mitigation priority is on-site. For organizations with large facilities, conservation technology may be installed in their facilities if it will completely mitigate the increased water use of the additional personnel. However, this will be done at the gaining organization's expense.

b. If the organization increases personnel and cannot reduce water use sufficiently at their facilities, the second method of mitigation requires working with the DIS. Cost for this mitigation method is $1,000 per additional employee. This money will be paid to the DIS and is a one-time fee per position added. The fee applies to all personnel increases, regardless of where the employee or contractor worked or was located before the hiring action. The mitigation fee is not an augmentation to the Garrison's appropriated funds budget because it pays to mitigate water consumption resulting from personnel increases that have not been otherwise funded by Department of the Army (DA) in the Garrison's annual budget.

Funds generated from requesting activities will be used to fund specific conservation measures. Principally, these will be water conservation technology, conservation easements, and storm water recharge. Activity funds will be obligated toward conservation measures within 12 months.

Fort Huachuca's current employee population baseline is 12,305. This includes permanent party military, government civilians, contractors, and family members, and military students who are at Fort Huachuca temporarily. The Army anticipates 12,805 soldiers and employees will be required to meet Fort Huachuca's future mission requirements. The Fort anticipates these mission requirements will arise over the next few years. By recognizing the need for mission flexibility and providing for an additional 500 personnel in the baseline number, Fort Huachuca can immediately meet new mission requirements as they arise without further section 7 consultation.

The Fort calculates the additional water needs associated with a 500-personnel increase to be 208 AF per year of water use beginning in 2003. It is unlikely that the full 208 AF will be realized in 2003. This increase is included in the analysis of projected pumping, Appendix M of the BA.

Erosion Control

Fort Huachuca has taken several actions to identify, monitor and improve watershed conditions across the installation. These actions include: mesquite root-plowing, upland revegetation,

gabions, erosion control structures, soils mapping, cooperative efforts with other Federal land managers, working with the Natural Resources Conservation District, and plant inventories. To reduce erosion, all off road vehicle traffic is prohibited on the installation. Any disturbance of more than one acre requires a Storm Water Pollution Prevention Plan. Most plan components include silt fencing, water bars, and other best management practices. Fort Huachuca is also retiring 81 miles of unnecessary roads and trails on the East Range.

Fort Huachuca will direct its initial erosion control efforts mainly toward the East Range. Certain areas are more prone to erode because of soil properties and less vegetation. Proposed work will lower sediment loads, provide recharge, reduce velocity of storm water, and protect archeological sites on the East Range.

East Range

Based on the East Range Watershed Improvement Plan, the following work is underway or scheduled:

Graveyard Gulch retention structure under construction. Awarded in 2002 for $344K ($58K Design in 01).

Soldier Creek similar work is projected for 2004.

Phase III similar work is projected for 2006.

Phase IV similar work is projected for 2007.

Phase V similar work is projected for 2008.

East Range road closures 81 miles.

Cantonment Area

There are also projects within the cantonment area which will reduce the potential impact of erosion. Status of these efforts is as follows:

Greely Hall Detention Basin Complete. This was a conservation measure to reduce impacts from increased pavement for parking near Greely Hall.

Hatfield Detention Basin Design Complete. Construction will begin in 2002.

West Range

The post is planning on a West Range retention structure for 2010.

Monitoring and Surveying of Listed and Candidate Species

Fort Huachuca has monitored listed, candidate, and sensitive species and conducted surveys on a recurring basis. Funding has been requested to continue monitoring.

Protection of Listed and Candidate Species

Fort Huachuca has implemented several actions to protect federally listed threatened and endangered as well as candidate species and their habitat across the installation. These include, but are not limited to the following measures:

Off-road travel and pyrotechnics are prohibited in agave management areas.

Off-road travel is prohibited.

Warning signs and physical protection (e.g., boulders, fencing, etc.) have been completed and are being maintained.

Annual reports have been submitted and current year work plans developed. Fort Huachuca proposes to continue to report and jointly develop work plans with the Service.

Fire Management

During fire suppression, prescribed fire, and managed natural fire activities on the installation, the following measures will be implemented:

One of the objectives of fire activities will be protection of agave, lesser long-nosed bat (LLNB), Huachuca water umbel, Mexican spotted owl, and Sonora tiger salamander populations. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

A Resource Advisor(s) will be on the fire during all activities. Resource Advisors will be qualified biologists designated to address listed and sensitive species concerns and serve as an advisor to the fire boss. They will also serve as field contact representatives responsible for coordination with the Service. They will monitor fire activities to ensure the protective measures endorsed by the fire boss are implemented. Resource Advisors will be on call 24 hours a day during the fire season.

Off-road vehicle activity will be kept to a minimum. Vehicles will be parked as close to roads as possible, and vehicles will use wide spots in roads or disturbed areas to turn around. If off-road travel is necessary, local firefighting units should go off-road first because of their knowledge of the area.

Use of tracked vehicles will be restricted to improving roads or constructing lines where a short distance of line might save a large area from fire.

The Fort will, to the extent possible, obliterate vehicle tracks made during the fire, especially those of tracked vehicles.

Areas disturbed for crew camps, landing strips, staging areas, and any other new areas of disturbance created during the fire will be kept to the minimum area possible and will be located in previously disturbed sites whenever possible.

The Fort in coordination with the Service will develop a mitigation and monitoring plan for each prescribed fire, managed natural fire, or fuels treatment that may adversely affect listed species. The plan will ensure that adverse effects to listed species and their habitat are minimized. The effects of prescribed fire and fuels treatment on listed species and its habitat will also be monitored. Mitigation and monitoring plans will be approved by the Service in writing before implementing prescribed fire or fuels management. Mitigation and monitoring for managed natural fire that has the potential to affect listed species will be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

The Fort will develop and implement a Fire Management Plan to address suppression and prescribed fire. As part of the planning effort, the Fort will establish a schedule and implement as soon as possible prescribed burns and fuel management to reduce fuel loading in Fort Huachuca woodlands to reduce the potential for stand-replacing fires.

The Fort Huachuca Fire Department will black line or burn out from Alpha Break into the area where ignitions are most prominent from Range 6 to Range 10. A line will be burned out along the north side of Range 6, the south side of Range 10, and along Alpha

Break One which is located up the canyon from where most ignitions occur on Range 9. In a normal year, a black line would be burned in the Spring and in the Fall if needed. The width of the line would vary with fuel type, topography, and with risk of escape beyond the break, but the goal will be to establish a black line 100 feet wide.

The Fort Huachuca Fire Department will be present on small arms firing ranges whenever tracer rounds are fired and will confine and contain any fires that are ignited in front of the black line to Alpha Break under appropriate conditions. All fires ignited west of Alpha Break will be managed as a suppression action.

Additional information is contained in specific species conservation measures and the project listing.

Recreation Management

Since September 2001, Fort Huachuca has been a closed post with access only by authorized personnel. At lower threat levels, recreational access is permitted with vehicle registration and proof of insurance. Night travel is prohibited on secondary roads including Huachuca and Garden Canyons. Recreation management measures that have been implemented include:

Boulder placement and warning signs around known populations of Huachuca water umbel;

Warning signs and boulder placement to protect Upper Garden Canyon Pond, Tinker Pond, and riparian areas;

Recreational restrictions to protect MSO and critical habitat;

Seasonal closure and protection of LLNB roost sites;

Closure of gate 7 to all vehicles;

Restricted vehicle access to include no off-road-vehicle use;

Additional restriction on the use of live bait as outlined in the Fort's fishing fact sheet;

Other measures are contained in the project list at the end of this section.

Environmental Awareness Education

The Fort will continue to provide information and education (including protected resource identification) to military units, civilians, contractors, and the general public. Range Scheduling, the ITAM coordinator, and ENRD will ensure that units training on the installation become familiar with environmental policies and operational requirements. Personnel training in the Huachuca Mountains will, through the environmental awareness training, be made aware of the protected status of listed species and these terms and conditions, but specific locations of listed species will not be revealed unless absolutely necessary to protect the species.

Also, information will be provided through the Newcomer's Briefing, Fort Huachuca 40-Hour Resource Conservation and Recovery Act (RCRA) course, Pre-Commander's Course, Fort Huachuca Conservation Committee, Environmental Quality Control Committee, and unit and organization briefings.

Integrated Natural Resources Management Plan (INRMP)

The Fort Huachuca INRMP was completed in November 2001 in compliance with Public Law 105-85, Sikes Improvement Act of 1997 (16 USC 670 *et seq.*). This plan provides the basis and criteria for protecting and enhancing natural resources using watershed, landscape, and ecosystem perspectives, consistent with the military mission. At a regional scale, the INRMP guides Fort Huachuca cooperation in renewable natural resources conservation at a landscape scale. The USFWS and AGFD have concurred with the plan, and it is currently being implemented.

Agave Management Plan

The Fort will continue to implement this plan to maintain self-sustaining natural populations of *Agave palmeri.* The preferred method is if a proposed construction site impacts more than 25 agave plants, the first alternative is to find another site. If unable to do so, the Fort will explore methods of transplanting agave that would otherwise be destroyed by construction activities. Previous transplantation efforts (primarily mitigation for training damage) have not been successful. Recommended methods that emerge from the experiment should be cost effective and exhibit reasonable long-term success (survival of at least 50% of wild plants of similar age classes in similar habitats). The agave management plan will be revised in 2003.

Species Specific Conservation Measures

Huachuca water umbel

1. Fort Huachuca will inventory all potential umbel habitat on the installation every three years with frequency transects conducted at documented umbel populations in the other two years.

2. On the SPRNCA, Fort Huachuca will inventory all potential umbel habitat every three years. No frequency transects will be done. All inventory and monitoring activities will be conducted from September 15 through October 31.

3. The Fort will maintain rock barriers around Huachuca water umbel populations.

4. The Fort will begin prescribed fire and fuel management in the Huachuca Mountains.

5. The Fort will maintain the barrier to vehicle travel at Gate No. 7.

6. General fire coordination will be done as specified in the fire management section of the conservation measures.

7. The Fort will fund water umbel habitat management or restoration where habitat has been degraded or lost, or where potential exists for creating water umbel habitat. Assistance will take the form of funding and technical assistance. Projects funded can include both off-post and on-post projects. On-post activities could include restoration and protection of cienega conditions in Garden Canyon and other wetlands. Off-post, the Fort could assist BLM, the Coronado National Forest, or other land owners and managers of water umbel habitat potentially affected by the proposed action. Off-post projects that the Fort should consider funding include cienega restoration or protection in Scotia Canyon or elsewhere in the Huachuca Mountains, if approved by and coordinated with the Coronado National Forest, and restoration or protection of cienega conditions on the San Pedro RNCA, if approved by and coordinated with the BLM. All plans and agreements for funded projects will be coordinated with and approved by the Service in writing.

8. The Fort will monitor and document any disturbance of umbel plants or habitat. This and other monitoring required here will be reported to the Service following the "reporting requirements described below.

9. Complete a Huachuca Water Umbel Endangered Species Management Plan in 2003.

10. All maintenance activities in Garden Canyon will occur within the existing roadbed or catch basins and only during the day. Silt fencing will be used where there is the potential for sediment to enter Garden Canyon Creek. No vegetation will be removed outside of the current roadbed and no invasive plant or animal species will be introduced. No water will be used from Garden Canyon Creek. Contractors will be trained to recognize Huachuca water umbel and required to follow these conservation measures.

11. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out most direct, indirect, interrelated and interdependent effects of the proposed action by 2011 (3,077 AF).

Lesser long-nosed bat

1. The Fort will ensure that construction, upgrading, or maintenance of roads does not increase or facilitate public access to Manila Mine, Pyeatt Cave, or other day roosts identified during the life of the project.

2. The Fort is in the process of installing a new surveillance system because the previous system was unreliable. The system will be operational by July 2002. Access routes at the closures and the mine and cave sites are posted with the following information: No vehicle access, no entry into mines or caves, explanations that the closures are needed to protect sensitive species, and warnings that entry into the mines or caves could represent a violation of the ESA. Fort Huachuca will maintain the signs. Current access control will continue with no access while lesser long-nosed bats are present, or from July 1 to October 31.

3. Monitoring will be conducted following Section 5.4.4 of the BA (ENRD 2002).

4. The Fort will prohibit low-level helicopter flights within 350 feet of Pyeatt Cave, Manila Mine, or other day roosts identified during the life of the project while lesser long-nosed bats are present, or from July 1 to October 31.

5. Before construction activities, preconstructing surveys will be conducted for paniculate agaves that may be directly affected by construction activities. If agaves are found during preconstructing surveys, the following measures will be implemented:

a. Disturbance will be limited to the smallest area practicable, damage to agaves will be avoided where possible, and projects will be located in previously disturbed areas whenever possible.

b. Vehicle use will be limited to existing routes and areas of disturbance except as necessary to access or define boundaries for new areas of construction or operation.

c. All workers will strictly limit their activities and vehicles to designated areas. Construction workers will be informed of these conditions.

6. No seeding or planting of nonindigenous grasses or other plants will occur at Fort Huachuca that may alter fire frequencies in wildland areas. However, seeding with proven hybrid sterile seeds in disturbed construction sites is authorized to establish a temporary ground cover for erosion control. This is only authorized during fall and spring when it is not feasible to seed with native species. Native species are always preferable to nonindigenous ones.

7. General fire coordination will be done as specified in the fire management section of the conservation measures. Prescribed fire and managed natural fire will be planned to minimize adverse effects to lesser long-nosed bat forage plants and roosts. Measures will be developed to ensure the following:

a. The fire kills no more than 20% of agaves that are burned during prescribed or managed natural fire.

b. Fires in agave management areas will be actively suppressed unless the area is approaching its natural fire return interval of 10 years.

c. Prescribed fire will be prohibited in agave management areas where greater than half of those agaves are young age classes (agaves with four or fewer spiral courses of leaves).

d. A mitigation plan will be developed by the Fort in coordination with the Service for each prescribed or managed natural fire within 0.5 mile of a lesser long-nosed bat roost or in areas that support paniculate agaves. The mitigation plan will ensure those effects to lesser long-nosed bat roosts and forage plants are minimized and will include monitoring of effects to forage plants. The Service will approve the plan in writing. Mitigation and monitoring for managed natural fire will be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

e. A schedule for prescribed burns will be established and followed to reduce fuel loading in Fort Huachuca grasslands and woodlands, thereby reducing the potential for major wildfires in lesser long-nosed bat foraging and roosting habitat. This schedule will be coordinated and approved by the Service in writing.

f. Nighttime training will not occur in agave management areas from July 1 through October 31.

8. No nighttime use and no tracer fire will occur on live fire ranges 2, 3, and 4 from July 1 through October 31.

9. From July 1 to October 31, all nocturnal UAV operations at the Rugge-Hamilton and Shadow (formerly Pioneer) sites will be above 500 feet agl, except for take off and landings. Take off and landing approaches at Rugge-Hamilton will be confined to the east and north and approaches at Shadow will be confined to the north and west, away from agave management areas. Nocturnal rocket-assisted take off of UAVs from the Black Tower site will only occur from November through June. Rocket-assisted take off will be attended by fire crews due to the high probability of fire and potential adverse effects to agave communities.

10. Off-road vehicle travel will not occur in protected agave management areas or any other part of the West Range or South Range.

11. Pyrotechnics will not be used within 0.25 mile of protected agave management areas.

12. The Fort will develop an endangered species management plan for the lesser long-nosed bat by June 2003.

13. The Fort will conduct monitoring of Palmer's agave populations on the West and South Ranges every five years. The objective of the monitoring will be to establish trends in bat forage resources.

14. Fort Huachuca will continue to monitor near the Bergey wind turbine and wind data towers. If LLNB are found dead at the base of these structures, the Fort will stop operation of the wind turbine and reinitiate formal consultation.

15. The Fort will monitor take of lesser long-nosed bats, document any disturbance of roost sites, and document acres burned on the West or South ranges and whether such fire burned in agave management areas. The results of this monitoring will be reported to the Service following the "reporting requirements below.

Sonora tiger salamander

1. Fort Huachuca will do annual monitoring of the upper Garden Canyon pond in June or early July (pre-monsoon) of each year to determine condition of the habitat and presence of aquatic salamanders according to the protocol approved by the Service.

2. General fire coordination will be accomplished as specified in the fire management section of the conservation measures. One of the objectives of fire suppression activities will be protection of salamanders and the aquatic habitat at upper Garden Canyon pond, in Scotia Canyon, or other

salamander localities possibly affected by fire at Fort Huachuca. This objective will not in any way constrain the fire incident commander from taking any action as needed to protect life or property.

3. The Fort will meet the objectives contained in the Endangered Species Management Plan for the Sonora tiger salamander.

4. The Fort will maintain boulders placed around the perimeter of Upper Garden Canyon Pond to prevent vehicles from driving through the habitat.

5. A closure to vehicle travel will be maintained for Gate No. 7.

6. The Fort has amended its Fishing Facts Sheet and posted on the Fort Huachuca web site to read: "i. Live fish and salamanders may not be transported or used as bait on Fort Huachuca. Capture, transport, or release of salamanders is strictly prohibited. This appears in bold. This revision has also been completed on the Fort's Fishing Fact Sheet and will continue to be included in annual updates.

7. The Fort will maintain the permanent all-weather sign posted at upper Garden Canyon ponds. The sign contains the following information: Fishing, use of nets, and capture or release of salamanders or fish is prohibited; and off-road vehicle use is prohibited.

8. The Fort will monitor take of Sonora tiger salamanders and document any disturbance of salamanders or salamander habitat. Results of this and other monitoring required herein will be reported to the Service following the "reporting requirements below.

9. The Fort will establish a schedule and implement, as soon as possible, prescribed burns or fuels management to reduce fuel loading in Fort Huachuca woodlands.

Southwestern willow flycatcher

1. The Fort will maintain existing fire breaks on the East Range.

2. The Fort will vigorously suppress any fire on the eastern third of the East Range, except in the impact area, and implement all portions of the proposed action and proposed conservation measures relevant to fire suppression.

3. If surveys confirm the presence of southwestern willow flycatchers on Fort Huachuca, the Fort will take action to ensure that fire ignited on the training ranges does not spread to

flycatcher habitat and will work with the Service to develop and implement a plan to prevent any take of flycatchers.

4. The Fort has assessed habitat suitability for flycatchers at Research, Development, Testing, and Evaluation (RDTE) survey points along the San Pedro River and found that none exists. Further habitat assessments will be conducted on a periodic basis, as needed, and discussed when the annual work plan is developed between Fort Huachuca and the Service.

5. Monitoring will be conducted per Section 4.4 of the BA. This includes habitat on Fort Huachuca, at the Babocomari Cienega, if permission is obtained, and throughout the SPRNCA in cooperation with the BLM. Surveys will adhere to Service protocol (Sogge et al. 1997). Surveys will include documenting flycatcher population size and distribution; identity of nesting birds (if banded); number of nesting attempts, clutch sizes, hatching success, and fledgling success; causes of nest loss or failure; breeding season length; and habitat use.

6. The Fort will monitor habitat conditions in the SPRNCA and habitat acquired or for which conservation easements or permission to enter are obtained. Aerial photos (1"=500 feet) were taken in 2000 and will be taken of the riparian corridor in 2004 and 2008. Vegetation maps were developed in 2001 and will be constructed from photo series within one year of obtaining the photographs. Resolution of the maps will be sufficient to map vegetation patches as small as 10 acres. Vegetation typing will be by plant species composition and vertical structure and foliage density. Sufficient ground-truthing will be conducted to assure reasonable accuracy of the mapping effort. Vegetation mapping in 2005 and 2009 will be accompanied by a trend analysis to determine gains or losses in flycatcher habitat.

7. The Fort will assist BLM or other land owners and managers of habitat on the Upper San Pedro River with flycatcher habitat management, or restoration on retired agricultural lands, grazed areas, and in other areas where flycatcher habitat has been degraded or lost. Assistance can take the form of funding or technical assistance. All plans and agreements for projects funded will be coordinated with and approved by the Service in writing.

8. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out most direct, indirect, interrelated and interdependent effects of the proposed action by 2011 (3,077 AF).

Mexican spotted owl

1. Fort Huachuca will conduct annual monitoring of currently known PAC's and surveys of potential Mexican Spotted Owl habitat at Fort Huachuca in accordance with Service survey protocol.

2. The Fort will complete the endangered species management plan for the MSO that conforms to and complements the MSO Recovery Plan by July 2003.

3. General fire coordination will be accomplished as specified in the fire management section of the conservation measures. Also, the following measures will be implemented:

a. Areas within PACs treated to reduce occurrence of wildfire, prescribed fire or fuels management will be monitored, as described in the Recovery Plan, to determine effects of the treatment on known owl habitat components. If adverse effects are detected, treatments will be modified to reduce those effects as much as possible while still reducing the risk of wildfire.

b. One of the objectives of fire suppression activities in the Huachuca Mountains will be protection of MSO PACs. This objective will not in any way constrain the fire incident commander from taking any action as needed to protect life or property.

c. If a MSO is encountered during a fire, the Resource Advisor will be told immediately. The Resource Advisor will assess potential harm to the MSO and advise the fire incident commander of methods to prevent harm. The Resource Advisor will maintain a record of any MSOs encountered during suppression activities. The information will include for each owl the location, date, and time of observation and the general condition of the MSO, and response to the fire and fire activities.

d. All fire suppression actions in PACs will occur, to the maximum extent possible, using "light on the land" methods, including not removing trees more than nine inches diameter at breast height (dbh) unless it is deemed necessary by the fire boss to prevent the fire from affecting additional PAC acres, or to protect life or property.

e. Patches of unburned vegetation within burned areas in the Huachuca Mountains will not be burned out as a fire suppression measure, except as needed to secure the fire perimeter or provide for fire fighter safety.

f. The Fort, in coordination with the Service, will develop a mitigation and monitoring plan for each prescribed fire, managed natural fire, or fuels treatment that may impact the MSO. Prescribed fire and fuels treatment will be designed to protect MSOs and their habitat. The mitigation and monitoring plan will contain the following, at a minimum:

i. Treatments and prescribed fire will not occur within a 100-acre area around MSO nest sites. This area will include habitat that resembles the structural and floristic characteristics of the nest site. The 100-acre area will be protected by using topographic and other barriers, or through line construction. All line construction in PACs will occur outside the MSO breeding season, will not remove any trees larger than 9 inches dbh unless they pose a threat to the safety of fire fighters, and will only occur with a resource advisor from the Fort on-site.

ii. Treatments will enhance or retain owl habitat components, such as downed large logs greater than 12 inches in midpoint diameter, hardwoods, grasses, forbs, and shrubs, while still reducing the chance of wildfire. In regard to downed logs, this will be achieved by protecting 80 to 90 percent of the downed logs 12 inches diameter or larger, and hand-lining snags 18 inches dbh or larger for all managed natural fire actions within PACs.

iii. Treatments will produce a mosaic of habitat components within PACs.

iv. Prescribed or managed natural fire will be introduced in PACs in blocks of 100-acres or less, and only between September 1 and February 28, outside the MSO breeding season.

v. Prescribed or managed natural fire will be introduced into potential MSO nesting and roosting habitat only if at least two years of surveys, in accordance with Service protocol has been conducted, and for which one year of follow-up survey (four visits) has been conducted, if more than one breeding season has elapsed since the last survey to protocol and the action. Also, introduction of fire into PACs will only occur if the nest/roost site is known the year of the action, or for which nest/roost site information is less than three years old. If nest/roost information for a PAC is three years old or more, a 200-acre nest buffer will be deferred from treatment until such a time, as the nest/roost can be located again.

vi. All prescribed or managed natural fire will be suppressed if it is anticipated that the fire may burn out of prescription in the following 24 hours. The Fort may choose to suppress actions before this.

vii. For prescribed or managed natural fire, the Fort will ensure that no more than 10 percent of the canopy of each PAC will be affected by gaps created by

single or groups of trees crowning. Groups of trees that "crown out" will not exceed two acres in size.

viii. The Fort will ensure that no more than two PACs per year on Fort Huachuca are affected by prescribed or managed natural fire. A PAC is considered affected if one or more acres of the PAC are burned to any degree. If prescribed or managed natural fires in one year are located in PAC(s) outside of the nest buffer, and are 1 to 10 acres in size, the Fort will discuss with the Service the option of allowing prescribed or managed natural fire to occur in one additional (or the same) PAC.

ix. The effects of prescribed fire, managed natural fire, and fuels treatment on the MSO and its habitat will be monitored. Such monitoring will include quantifying areas of 100-acre activity centers, PACs, and potential habitat affected by these activities.

x. The Service will approve mitigation and monitoring plans. Such plans will be developed before implementation of prescribed fire. Mitigation and monitoring for managed natural fire that may adversely impact the MSO will be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

xi. Areas of significant human activity during fire suppression operations, prescribed fire, or managed natural fire in the Huachuca Mountains such as fire crew camps, landing areas, and equipment staging areas, will be located outside of PACs. Areas disturbed during fire suppression activities in the Huachuca Mountains such as fire lines, crew camps, and staging areas will be rehabilitated, including the obliteration of fire lines to prevent their use by vehicles or hikers.

4. Within canyons containing active MSO nests, or in canyons where occupancy or reproductive status is unknown, the Fort will minimize low-level helicopter flights within 1 mile of the nest, or the site of the last previously known nest. Helicopter flights closer than 0.25 mile to active nests will be prohibited from March 1 to August 31.

5. If MSOs are found nesting in Garden Canyon within 0.25 mile of the rappelling cliffs, rappelling will be halted or moved at least 0.25 mile from the active nest from March 1 through August 31, or until nestlings fledge.

6. The Fort will maintain the permanent all-weather sign near the Scheelite Canyon trailhead (but not visible from the Garden Canyon Road) that informs visitors of the following:

a. The Canyon is home to sensitive species.

b. Visitors should stay on the trail and be as quiet and unobtrusive as possible.

c. Groups of visitors are limited to 12 or less.

d. Calling, hooting, or playing of taped recordings to elicit responses from or to locate owls is prohibited in Scheelite Canyon without special permit from the US Fish and Wildlife Service.

e. Smoking is prohibited.

7. All maintenance activities in Garden Canyon will occur within the existing roadbed or catch basins and will only occur during the day. Silt fencing will be used where there is the potential for sediment to enter Garden Canyon Creek. No vegetation will be removed outside of the existing roadbed and no invasive plant or animal species will be introduced. No water will be used from Garden Canyon Creek. Contractors will be trained to recognize MSOs and required to follow these conservation measures.

8. The Fort will monitor take of MSOs and document any disturbance of owls or owl habitat. This and other monitoring required here will be reported to the Service following the "reporting requirements described below.

Reporting Requirements

Fort Huachuca's schedule, by year and project, to accomplish the proposed conservation measures is provided in Table 7. The schedule extends only through fiscal year 2010, because that is when Fort Huachuca proposes to reduce its water consumption in the Sierra Vista subwatershed to zero. Additional information is in the BA regarding which projects will be implemented when, and are incorporated here by reference.

Proposed projects will be included in the annual work plan and discussed during the annual meeting with the Service. The status of projects, additions or deletions, and any revision to this schedule will be coordinated with the Service as appropriate through the annual work plan, annual meetings, annual reporting, or informal or formal consultation.

Management Responsibilities

Fort Huachuca is home to several military organizations including the USAIC (comprised primarily of the111th and 112th MI Brigades), Headquarters for the US Army Signal Command, the 11th Signal Brigade, the EPG, the Joint Interoperability Test Center, and other partner activities. As the management and scheduling authority for all military activities on Fort Huachuca, the Army is responsible for adherence to all conservation measures set forth in this BA and compliance with the resulting BO.

To ensure that operations will be conducted in compliance with environmental requirements that come from this consultation, a management representative (point of contact) will be designated from the Range Control Operations office. This management representative has the authority to halt activities that are inconsistent with the BO. The management representative will routinely coordinate with Fort Huachuca's ENRD. The ENRD will in turn coordinate with the designated Service representative on matters concerning this consultation.

All military units, agencies, and organizations using Fort Huachuca ranges and training areas are required to submit a range/training request to Range Scheduling, including information about the requested use, number and types of troops and vehicles, and length of training. Unit commanders ensure that personnel are adequately trained in natural resource protection procedures, that the unit has adequate fire suppression capabilities, and that all restrictions or guidelines for training or testing are followed. Both the Range Control Operations Office and the ENRD perform oversight of unit activities and training. Failure to follow all range procedures could result in loss or limitation of range privileges at the discretion of the Range Control Officer.

The Range Control Officer is responsible for reviewing range/training area requests; maintaining a database of range usage and training man-hours; performing scheduled or unscheduled checks of ranges and training areas to ensure compliance with range use procedures; and limiting use of ranges as required by environmental conditions.

HUACHUCA WATER UMBEL (*Lilaeopsis schaffneriana* var. *recurva*)

Status of the Species

The Huachuca water umbel was listed as an endangered species on January 6, 1997 (USFWS 1997a). Critical habitat was designated on the upper San Pedro River, Garden Canyon on Fort Huachuca, and other areas of the Huachuca Mountains, San Rafael Valley, and Sonoita Creek in 1999 (USFWS 1999b). The umbel is a herbaceous, semiaquatic perennial plant with slender, erect leaves that grow from creeping rhizomes.

Table 7. Approved projects for Fort Huachuca, Arizona.

	Project Funding $(000)							
Project Name	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10
Comply with BO (Water Mgt. Plan)	50	50	50	50	50	50	50	50
Comply with BO (USPP)	500	500	500	150	150	150	150	150
Comply w/BO (Monitor umbel & flycatcher in SPRNCA)	55	100	140	60	60	110	140	70
Comply w/BO (agave mgt)	50	90	90	50	50	30	30	30
Comply w/BO (aquatic species mgt)	35	85	85	90	90	90	90	90
Comply w/BO Implement ESMP (Cand spp)	30	30	30	30	30	30	30	30
Comply with BO (Protect SWWF habitat)	325	325	325	325	325	325	325	325
Implement INRMP (Invasive Species)	100	50	50	50	50	50	50	50
Implement INRMP	125	125	160	160	160	160	160	160
Comply with BO (MSO/pereg)	40	60	60	60	60	60	60	60
Comply w/BO (Water Conservation)	308	300	300	500	400	200	200	200
Comply w/BO (Fire Mgt)	120	160	160	160	170	170	170	170
Comply w/BO (MOA w/Forest Service)	25	25	30	30	30	30	30	30
Comply w/BO (LLNB Mgt)	50	50	40	40	40	40	40	40
Implement ESMP (BA)	10	10	10	10	10	10	10	10
Implement ESMP (Subsurface Survey)	100	100	100	100	100	100	100	100
Implement INRMP (EA)	30	30	30	30	30	30	30	30
Implement ESMP (Spotted Owl)	50	60	60	60	60	60	60	60
Implement ESMP (Mountain Front Recharge)	150	500	150	150	100	100	100	100
PROJECT TOTAL	2153	2650	2370	2105	1965	1795	1825	1755
Program Management (CNS)	430	430	452	458	458	458	458	458
ECAP TOTAL	2583	3080	2822	2563	2423	2253	2283	2213

Huachuca water umbel has been documented from 27 sites in Santa Cruz, Cochise, and Pima counties, Arizona, and in adjacent Sonora, Mexico, west of the continental divide (Warren et al. 1989, Saucedo Monarque 1990, Warren et al. 1991, Warren and Reichenbacher 1991, Haas and Frye 1997, Titus et al. 2002, Service files). The plant has been extirpated from 6 of the 27 sites. The 21 extant sites occur in four major watersheds - San Pedro River, Santa Cruz River, Rio Yaqui, and Rio Sonora. All sites are 3,500 to 6,500 feet in elevation.

Huachuca water umbel has an opportunistic strategy that ensures its survival in healthy riverine systems, cienegas, and springs. In upper watersheds that generally do not experience scouring floods, the umbel occurs in microsites where interspecific plant competition is low. At these sites, the umbel occurs on wetted soils interspersed with other plants at low density, along the periphery of the wetted channel, or in small openings in the understory. The upper Santa Cruz

River and associated springs in the San Rafael Valley, where a population of Huachuca water umbel occurs, is an example of a site that meets these conditions. The types of microsites required by the umbel were generally lost from the main stems of the San Pedro and Santa Cruz Rivers when channel entrenchment occurred in the late 1800's to early 1900's. Habitat on the upper San Pedro River is recovering, and Huachuca water umbel has recently been found along many reaches of the main channel.

In stream and river habitats, Huachuca water umbel can occur in backwaters, side channels, and nearby springs. After a flood, it can rapidly expand its population and occupy disturbed habitat until interspecific competition exceeds its tolerance. This response was recorded at Sonoita Creek in August 1988, when a scouring flood removed about 95 percent of the Huachuca water umbel population (Gori et al. 1990). One year later, the umbel had recolonized the stream and was again codominant with watercress, *Rorippa nasturtium-aquaticum* (Warren et al. 1991). The expansion and contraction of Huachuca water umbel populations appear to depend on the presence of "refugia where the species can escape the effects of scouring floods, a watershed that has an unaltered hydrograph, and a healthy riparian community that stabilizes the channel.

Density of umbel plants and size of populations fluctuate in response to both flood cycles and site characteristics. Some sites, such as Black Draw, have a few sparsely-distributed clones, possibly due to the dense shade of the even-aged overstory of trees, deeply entrenched channel, and dense nonindigenous herbaceous layers beneath the canopy. The Sonoita Creek population occupies 14.5 percent of a 5,385 ft^2 patch of habitat (Gori et al. 1990). Some populations are as small as 11 to 22 ft^2. The Scotia Canyon population, by contrast, has dense mats of leaves. Scotia Canyon contains one of the larger Huachuca water umbel populations, occupying about 57 percent of the 4,756 foot perennial reach (Gori et al. 1990, Falk and Warren 1994).

Erosion and stability of perennial systems are the primary management factors of concern for this species. In addition, wildfires are of concern because of increased erosion, reduced water infiltration, and other negative impacts that can occur after a fire (Rinne and Neary 1996). Excessive rates of erosion and disturbance near a site from wildfires, recreationists, or road construction could increase the chance of a flash flood that could scour a population. Likewise, the reduction or diversion of water could eliminate a site (AGFD 1997).

Overgrazing, mining, hay harvesting, timber harvest, fire suppression, and other activities in the nineteenth century led to widespread erosion and channel entrenchment in southeastern Arizona streams and cienegas when above-average precipitation and flooding occurred in the late 1800's and early 1900's (Bryan 1925, Martin 1975, Hastings and Turner 1980, Dobyns 1981, Hendrickson and Minckley 1984, Sheridan 1986, Bahre 1991, Webb and Betancourt 1992, Hereford 1993). A major earthquake near Batepito, Sonora, about 40 miles south of the upper San Pedro Valley, resulted in land fissures, changes in groundwater elevation and spring flow, and may have preconditioned the San Pedro River channel for rapid flood-induced entrenchment

(Hereford 1993, Geraghty and Miller, Inc. 1995). These events contributed to long-term or permanent degradation and loss of cienega and riparian habitat on the San Pedro River and throughout southern Arizona and northern Mexico. Much habitat of the Huachuca water umbel and other cienega-dependent species was presumably lost then.

Wetland degradation and loss continue today. Human activities such as groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, agriculture, mining, sand and gravel operations, road building, nonindigenous species introductions, urbanization, wood cutting, and recreation all contribute to riparian and cienega habitat loss and degradation in southern Arizona. The local and regional effects of these activities are expected to increase with the ever increasing human population.

Dredging extirpated the Huachuca water umbel from House Pond, near the extant population in Black Draw (Warren et al. 1991). The umbel population at Zinn Pond in St. David near the San Pedro River was probably lost when the pond was dredged and deepened. This population was last documented in 1953 (Warren et al. 1991).

Livestock grazing can affect the umbel through trampling and changes in stream hydrology and loss of stream bank stability. However, existence of the umbel appears to be compatible with well-managed livestock grazing (USFWS 1997a). In overgrazed areas, stream headcutting can threaten cienegas where the umbel occurs. Such headcutting occurs at Black Draw just south of the international boundary and at Los Fresnos, in the San Rafael Valley, Sonora. Groundwater pumping has eliminated habitat in the Santa Cruz River north of Tubac, and threatens habitat in the San Pedro River. Portions of the San Pedro River occupied by the umbel could be dewatered unless measures are implemented to halt or mitigate groundwater pumping in the upper San Pedro basin (ASL Hydrologic and Environmental Services [ASL] 1998). Severe, unmanaged recreational impacts can compact soils, destabilize stream banks, and decrease riparian plant density, including densities of the Huachuca water umbel. Populations in Bear Canyon in the Huachuca Mountains have been impacted by trampling and off-highway vehicles.

A suite of nonindigenous plant species has invaded wetland habitats in southern Arizona (Stromberg and Chew 1997), including those occupied by the Huachuca water umbel (Arizona Department of Water Resources 1994). In some cases their effect on the umbel is unclear. However, in certain microsites, the nonindigenous Bermuda grass, *Cynodon dactylon*, may directly compete with the umbel. Bermuda grass forms a thick sod in which many native plants are unable to establish. Watercress is another nonindigenous plant now abundant along perennial streams in Arizona. This plant is successful in disturbed areas and can form a dense monoculture that can out compete Huachuca water umbel populations.

Limited numbers of populations and the small size of populations make the Huachuca water umbel vulnerable to extinction as a result of stochastic events that are often exacerbated by

habitat disturbance. For instance, the restriction of this taxon to a relatively small area in southeastern Arizona and adjacent Sonora, Mexico increases the chance that a single environmental catastrophe, such as a severe tropical storm or drought, could eliminate populations or cause extinction. Populations are in most cases isolated, as well, which makes the chance of natural recolonization after extirpation less likely. Small populations are also subject to demographic and genetic stochasticity, which increases the probability of population extirpation (Wilcox and Murphy 1985, Shafer 1990).

Environmental Baseline

The environmental baseline includes past and present impacts of all Federal, state, or private actions in the action area; the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation; and the impact of state and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

At and in the vicinity of Fort Huachuca, extant *Lilaeopsis* populations occur on the San Pedro River on lands managed by the Bureau of Land Management, in canyons of the Huachuca Mountains on the Fort, and on lands managed by the Coronado National Forest or owned by private individuals. Two extirpated populations in the upper San Pedro watershed occurred at Zinn Pond in St. David and the San Pedro River near St. David.

San Pedro River Localities of the Huachuca Water Umbel

The upper San Pedro River is characterized by a relatively broad floodplain that meanders through the San Pedro River Valley. The riparian zone consists of cottonwood-willow and herbaceous associations near the river channel, and mesquite bosques on the higher terraces. Pond and marshland communities, saltcedar (*Tamarix chinensis*) four-wing saltbush (*Atriplex canescens*) and sacaton (*Sporobolus* spp.) associations also exist in the riparian zone of the river. The upper San Pedro River is perennial from about Hereford to about four miles north of the Charleston Stream Gage. The Babocomari River, which drains portions of the Mustang, Huachuca, and Whetstone mountains, and the Canelo Hills, is the largest tributary and enters the San Pedro River just south of Fairbank. O'Donnell Creek, Ramsey Canyon, and Miller Canyon are other important tributaries ([ASL] 1994.)

Hydrologists have divided the upper San Pedro River into two subwatersheds, including: 1) Sierra Vista subwatershed, which includes the river and its watershed from the international boundary north to a point about three miles north of Fairbank, and 2) Benson subwatershed, which includes the river and its watershed from the northern boundary of the Sierra Vista subwatershed north to the "Narrows" several miles north of Benson (ADWR 1991). Two major

diversions of surface flow have occurred on the upper San Pedro River in the Benson subwatershed, including: 1) St. David ditch, located north of the Babocomari River and about five miles south of St. David, and 2) Pomerene Canal (ADWR 1994). All surface flow of the river up to 24 cfs is diverted into the St. David ditch for use by the St. David Irrigation District (ADWR 1991, Steve Lacey, Fluid Solutions, Phoenix, pers. comm., 1999). The perennial reach of the San Pedro River, as defined by ADWR (1991), ends at the St. David diversion. This diversion is just inside the northern boundary of the San Pedro Riparian National Conservation Area (SPRNCA). The Pomerene Canal diversion is in place and repairs are planned after the 2002 monsoon season (J. Hessil, pers. comm., August 2002).

The San Pedro RNCA was designated in 1988. The SPRNCA, which is managed by the BLM, includes roughly 57,000 acres in a strip about 36 miles long and 2.6 miles wide that runs from the international boundary north to about 3 miles south of St. David (but there is about a two-mile gap in the SPRNCA just north of Palominas and a section just north of Lewis Springs). The purposes of the SPRNCA as defined in the legislation are to conserve, protect, and enhance the riparian area and the aquatic, wildlife, archeological, paleontological, scientific, cultural, educational, and recreational resources of the area. The legislation established a Federal reserve water right adequate to fulfill the purposes of the SPRNCA. The riparian corridor through the SPRNCA is one of the most extensive, contiguous reaches of cottonwood-willow gallery forests in the southwestern United States (U.S. BLM 1998).

The Huachuca water umbel was found on the San Pedro RNCA in 1994. Mark Fredlake (U.S. BLM), Peter Warren, and Dave Gori (The Nature Conservancy) located 43 patches of Huachuca water umbel during 1995 and 1996. Haas and Frye (1997) identified eight additional patches in 1997. These patches were found in six disjunct areas, including about two miles downstream of Fairbank, near Brunchow Hill upstream of Charleston, in the river at Lewis Springs, about one mile north and south of Highway 90, approximately 2.5 miles downstream of Highway 90, and from Hereford Bridge north for about one mile. Haas and Frye (1997) also documented the species on the San Pedro River about 0.5 mile south of the international boundary. Joanne Kirchner and Karen Blumenthal (EEC 2001a), under contract to the Fort, inventoried 31.7 miles of the 33.7 miles of the designated critical habitat within the SPRNCA. They identified 43 populations during the inventory (Figure 7). Of these 43 populations, 17 appear to be new locations when compared with BLM records dated 1995 to 1999.

Two patches of Huachuca water umbel on the San Pedro River were lost during a winter flood in 1994 and had still not recolonized that area as of May 1995, demonstrating the dynamic and often precarious nature of occurrences within a riparian system (Al Anderson, Grey Hawk Ranch, *in litt.*, 1995). However, after high flows in 1996, no apparent loss or reductions in about 12 Huachuca water umbel patches were noted by Dr. Peter Warren (pers. comm., 1997). In 1999, Fredlake documented the absence of Huachuca water umbel in a historical site north of the Hereford Bridge/river crossing. In October 2000, a major flood event occurred which restricted access to the river to conduct surveys. Fredlake re-documented this population during spring

2001 surveys. Also, Kirchner and Blumenthal documented this population during fall 2001 inventory. After the October flood in 2000, it appears that water umbel colonized downstream of the historically most densely populated areas within the SPRNCA, demonstrating persistence by this plant in a natural functioning riverine system (EEC 2001a). The entire San Pedro RNCA is considered potential habitat for the Huachuca water umbel. It is the largest contiguous potential habitat of the umbel, and as such is considered the most important site for recovery.

Comparison of current conditions with accounts of explorers and others who visited the San Pedro River more than a century ago suggests that cienegas and wetlands have largely disappeared or have been replaced by riparian woodlands. When Padre Kino visited the San Pedro River in the late 1600's, he encountered an unincised marshy river where the native Sobaipuri people were living and irrigating several types of crops with water diverted from the river through canals (Kino 1919, Hendrickson and Minckley 1984). The river bottom was heavily stocked with cattle in the early part of the 1800's, but ranches were abandoned. Wild livestock left behind were abundant when explorers visited the San Pedro in the mid-1800s, but despite this grazing, the river in 1846 was described as a "marshy bottom with plenty of grass and water" (Cooke 1938), and was characterized by tall grasses that were difficult to pass through (Cooke 1938, Evans 1945). Boggy banks and swampy conditions were described by Eccleston (1950). Cottonwoods, willows, and other riparian trees were present (Leach 1858, Parke 1857), but most descriptions suggest they were less evident than today, and that cienega conditions prevailed (Hendrickson and Minckley 1984). This characterization is however, contrary to some descriptions from the period indicating the river was incised near St. David and Benson (Parke 1857, Bartlett 1854). Hendrickson and Minckley (1984) suggest entrenchment was local and discontinuous in the mid 1800's. The marshy, cienega conditions encountered by explorers in the 1800's were likely ideal habitats for the Huachuca water umbel. A series of large floods resulted in channel entrenchment between 1880 and 1908 (Hereford 1993), and possibly as late as 1926 (Jackson et al. 1987). Flooding and downcutting left the river channel 3 to 30 feet below the former floodplain (Hereford 1993), which would have left most of the marshy bottomlands, and the habitat of the water umbel, high and dry. Completion of two cross-continental railways across Arizona in the 1880's, military conquest of the Chiricahua Apaches, and discovery of extensive silver deposits near Tombstone in the late 1870's spurred a boom in the mining and livestock industries and facilitated settlement and development of the area (Rogers 1965). Watershed degradation caused by extensive mining, wood cutting, and heavy grazing exacerbated the effects of unusually heavy rainfall, resulting in entrenchment of the river channel and loss of cienega habitats (Jackson et al. 1987, Hereford 1993, ADWR 1994, Geraghty and Miller, Inc. 1995). Other factors that affected the distribution and abundance of cienega conditions on the San Pedro River include elimination of beavers and a major earthquake (DuBois and Smith 1980, Geraghty and Miller, Inc. 1995, San Pedro Expert Study Team 1999). Through construction of dams, beaver, *Castor canadensis*, probably contributed to the abundance of marshy, boggy conditions on the San Pedro River observed by explorers before entrenchment. However, as a result of over harvest, beaver were eliminated from the upper San Pedro, possibly near the turn of the century (Fredlake 1996). Following a major earthquake in 1887, the epicenter of which was located about 40 miles south of the upper San Pedro Valley, cienegas near St. David dried up, while in other areas artesian flows developed. The earthquake may have

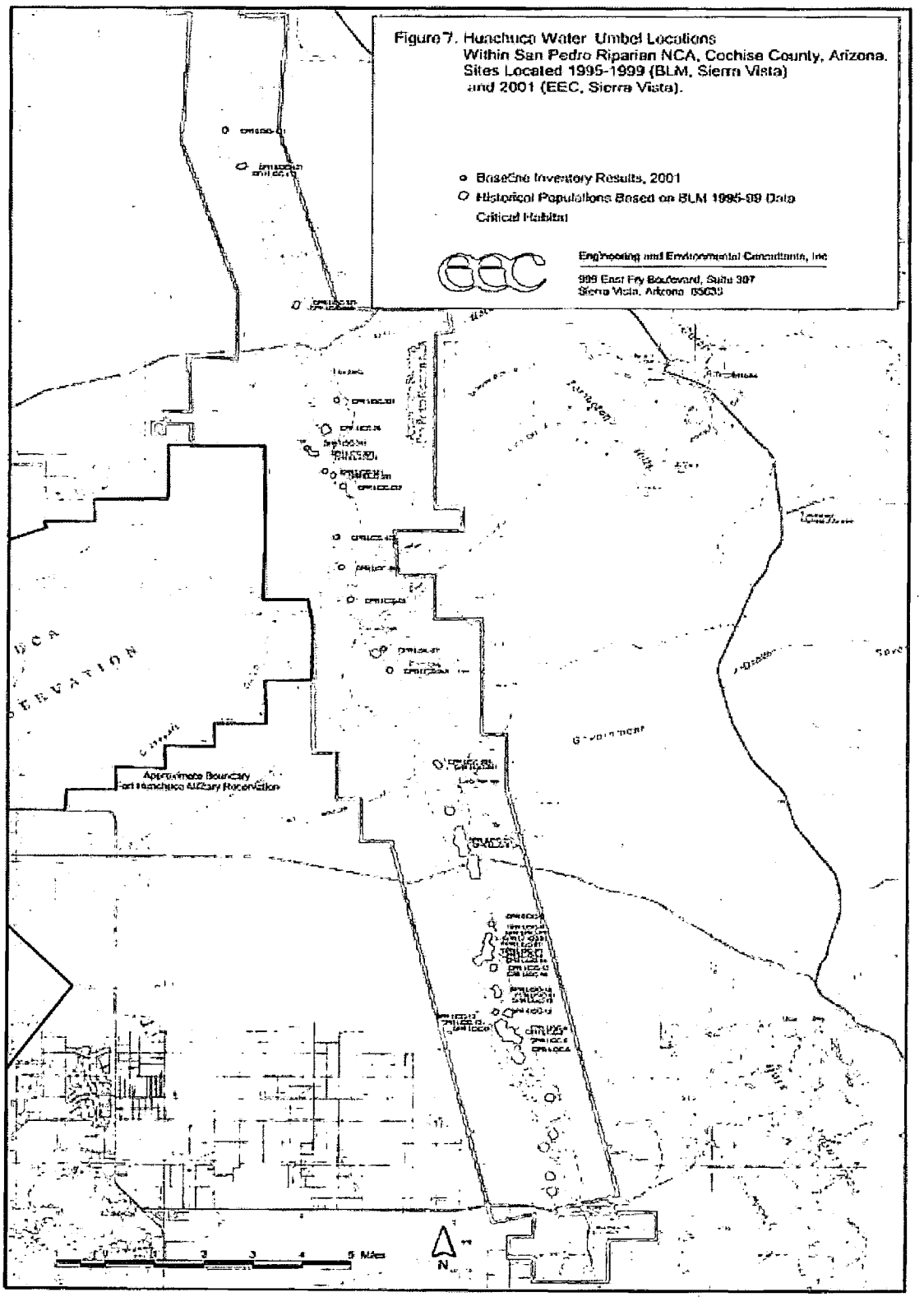
Figure 7. Huachuca Water Umbel Locations
Within San Pedro Riparian NCA, Cochise County, Arizona.
Sites Located 1995-1999 (BLM, Sierra Vista)
and 2001 (EEC, Sierra Vista).
BaseOne Inventory Results, 2001
Historical Populations Based on BLM 1995-99 Data
Critical Habitat
Engineering and Environmental Consultants, Inc
999 East Fry Boulevard, Suite 307
Sierra Vista, Arizona 85635
Approximate Boundary
Fort Huachuca Military Reservation
5 Miles
N

contributed to conditions that lead to channel entrenchment (Hereford 1993, Geraghty and Miller, Inc. 1995). With resulting loss of cienega conditions, the Huachuca water umbel probably became extremely limited in distribution or disappeared from the San Pedro River at this time. It was collected from the San Pedro River in 1958 (Warren et al. 1989), which may have represented a remnant population.

Since entrenchment during 1880 to 1926, the river channel has widened substantially, peak flows have declined, sinuosity of the channel has increased, and riparian woodlands have developed on the floodplains (Hereford 1993). Hereford (1993) suggests that "increased sinuosity produced a reservoir effect that attenuated flood waves, and the development of floodplains enabled flood waters to spread laterally, thereby increasing transmission losses." Improvements in watershed condition and resulting increased infiltration and reduced runoff may have also contributed to reduced peak flows.

Few direct human impacts to umbel habitat in the San Pedro River have occurred since establishment of the SPRNCA. However, recreation and associated impacts are becoming increasingly evident. About 13 fires have burned within the SPRNCA since its acquisition by BLM. A wildfire just north of the Highway 90 bridge destroyed 780 acres of riparian woodlands and grasslands in late May and June 1998. Another fire, apparently caused by a downed power line, burned about 800 acres in the SPRNCA in March 1999. In May 2000, about 375 acres of habitat burned near Highway 90 bridge to Lewis Springs. The cause of the fire is unknown, but recreational activities are likely to increase the incidence of fire in the future. Recreation may be adversely affecting the umbel through trampling and bank erosion in some areas, particularly at the Highway 90 locality. Removal of most livestock after establishment of the SPRNCA stimulated a recovery of riparian and wetland plant communities. Trespass cattle along the river were causing localized trampling of water umbel sites near the Highway 90 crossing in 1997, and continue to be a problem in some areas of the SPRNCA, but the BLM has stepped up efforts to control trespass cattle. The immediate watershed of the upper San Pedro River continues to be degraded to some extent by livestock grazing. Disturbance of soils and cryptobiotic crusts, and removal of vegetation in the watershed by grazing combine to increase surface runoff and sediment transport, and decrease infiltration of precipitation (Gifford and Hawkins 1979, Busby and Gifford 1981, DeBano and Schmidt 1989, Belsky and Blumenthal 1997). Degraded watershed condition due to grazing is particularly evident along Highway 90 north of Huachuca City where grasses have been largely eliminated. Between 1974 and 1987, grassland communities in the upper San Pedro basin decreased in cover by 35 percent (U.S. EPA 1997) and have been replaced by desert scrub communities (Figure 8). The figure also shows that mesquite woodlands have increased at the expense of both desert scrub and grassland.

The beaver was eliminated from the upper San Pedro River basin probably circa 1900. The BLM and Arizona Game and Fish Department recently reestablished several beaver into the SPRNCA between the Hereford Bridge and the Highway 90 bridge. The effects of reestablishing beaver into the river system were the subject of formal section 7 consultation between the Service and BLM. In the biological opinion, the Service found the proposed

reestablishment would not jeopardize the continued existence of the Huachuca water umbel. Beaver could facilitate reestablishment of cienega conditions through construction of dams and ponding of water. Effects on existing individual plants or populations of plants cannot be determined and would depend on the location and extent of beaver activity and the level of success of the beaver reestablishment program.

The greatest threat to umbel habitat on the San Pedro River is continued groundwater pumping in excess of recharge, which has the potential to lower groundwater elevation under portions of the river, eliminate base flows, and result in dessication of the riparian and wetland vegetation communities (ADWR 1994, Stromberg et al. 1996, U.S. BLM 1998). The hydrology of the upper San Pedro Basin and associated topics have been studied by numerous investigators, particularly in the last decade (i.e., Arizona Water Commission 1974, Freethy 1982, Jackson et al. 1987, Putman et al. 1988, ADWR 1991, 1994, Braun et al. 1992, Vionnet and Maddock 1992, Hereford 1993, Water and Environmental Systems Technology, Inc. 1994, 1996 [WESTEC], ASL 1994, 1995, 1998, Lacher 1994, Corell 1996, Corell et al. 1996, Stromberg et al. 1996, Sharma et al. 1997; Wynn and Gettings 1997, Goodrich et al. 1998, Koehler and Ball 1998, MacNish 1998, Pool et al. 1998, Coes et al. 1999, Pool and Coes 1999). Much of the recent work has been driven by a water rights adjudication in the Gila River basin, which includes the upper San Pedro River, and concerns that groundwater pumping in the Sierra Vista subwatershed may result in declining groundwater elevations and loss of base flow and riparian values along the San Pedro River.

Hydrology of the Upper San Pedro River Basin: River Flow and Trends

The purpose of this subsection is to discuss the current baseline conditions and the potential effects of groundwater use in the Sierra Vista subwatershed. Fort Huachuca proposes to implement conservation measures which should mitigate or offset all direct, indirect, interrelated and interdependent effects of water usage associated with the presence of Fort Huachuca in the Sierra Vista subwatershed.

Flows in the upper San Pedro River are considered intermittent from the Mexican boundary to about four miles north of Palominas. The river is mostly perennial through the SPRNCA to about four miles north of the Charleston Stream Gage, after which it is intermittent (ASL 1994). Table 8 presents median monthly stream flows at the three gaging stations maintained by U.S. Geological Survey, including the Palominas Gage (T23S, R22E, S33), the Charleston Gage (T21S, R21E, S11), and the Tombstone Gage (T19S, R21E, S28). The greatest discharges are often recorded at the Tombstone Gage, although this is a "losing reach (the river loses water to the floodplain aquifer)(Jackson et al. 1987, ASL 1994). Flows at the Tombstone Gage are bolstered by inflows from the Babocomari River and Walnut Gulch, which both flow during and after precipitation events, but contribute little to base flow (ASL 1994). Flows largely correspond to precipitation in the watershed; and are lowest in May, June, and early July during

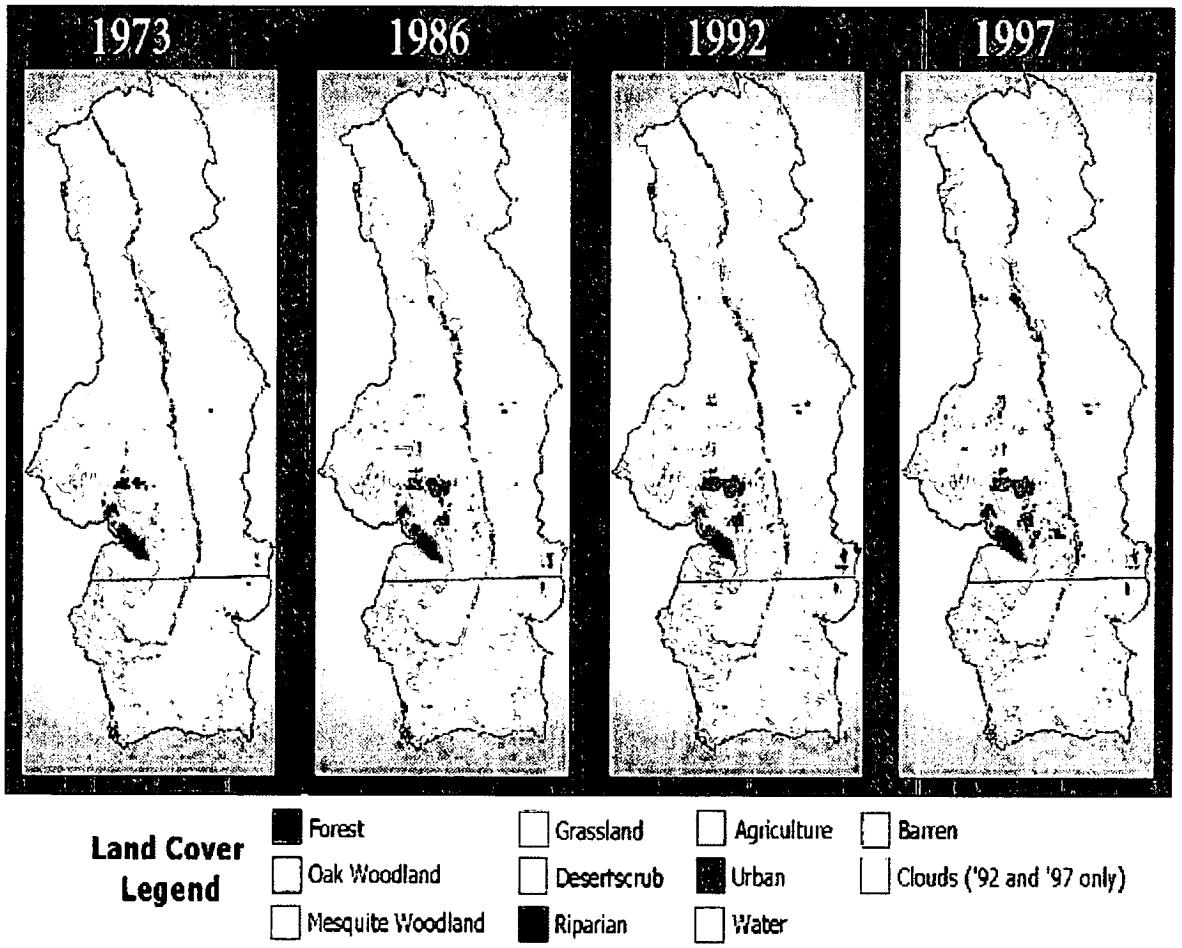

Figure 8. Vegetation change in the upper San Pedro River basin, Arizona, from 1973 to 1997.

the dry season, and are greatest during the summer monsoons in mid to late July and August or in winter.

Numerous studies have been conducted to gain a better understanding of the hydrogeology of the USPB. Some of these studies involved actual field survey and data collection, but some were modeling efforts, and others provided a review of existing information. All of these studies differ to some extent in purpose and scope but can be grouped into four general categories (which overlap): basic research, water supply, planning, and mitigation.

Because most of these studies are based upon the same data sources, there is much repetition, both in the data presented and in the interpretation of the data. Despite ongoing efforts to fill the gaps in the knowledge base, none of the studies available to date fully describes or explains the complex hydrogeology of the USPB.

Table 8. Median monthly stream flow (cubic feet per second [cfs]) for the San Pedro River Sierra Vista subwatershed 1931 to 1983 (from Jackson et al. 1987), Arizona.

Month	Gaging Station		
	Palominas	Charleston	Tombstone
January	10.9	23.5	35.8
February	8.6	20.3	32.1
March	6.3	18.9	29.1
April	2.5	12.2	15.7
May	1.2	7.9	1.4
June	0.6	4.2	3.0
July	15.7	29.1	67.2
August	51.9	91.6	18.4
September	10.7	24.2	18.4
October	3.7	12.2	13.0
November	3.6	13.6	12.2
December	5.5	17.1	20.2

The scientific community has debated the role and effect of regional volcanism on groundwater resources in the USPB (see Vionnet and Maddock 1992, ASL 1994, Geraghty and Miller 1995, Wynn and Gettings 1997). Recent geophysical data has produced a new conceptual model that differs from the previous models. The geographic region south of the confluence of the Babocomari and San Pedro Rivers is the focus of this debate. While immediately relevant to the geographic areas covered in this BO, it was clear that such controversial scientific and conceptual issues will not be resolved before this BO is completed. At present, there is not adequate scientific data to support definitive conclusions regarding the complexities of local hydrology; however, there is evidence to support general findings.

There has also been considerable speculation regarding the impact of groundwater development upon surface flows of the San Pedro River. These issues have been contested in both scientific and legal forums (USDC 1995). Given this level of controversy, it is clear that detailed questions regarding the long-range impact of regional groundwater development on surface water features cannot be answered conclusively. The exact scientific cause and effect will remain the subject of future investigation. However, there is a volume of scientific evidence, including

expert testimony provided by the State of Arizona that development and use of groundwater on Fort Huachuca have "not caused a change in groundwater discharge to the San Pedro River, nor has it diminished the river's surface water flow rate or volume (ADWR 1996).

Figure 9 shows the typical daily stream flow pattern of the San Pedro River at Charleston (Koehler and Ball 1998). Koehler and Ball (1998) also present a graphing technique of the San Pedro River at Charleston showing the entire daily flow record from 1935 to 1999 (Figure 10). The typical seasonal patterns of winter, spring decline (pre-monsoon or dry season), monsoon (wet season), post-monsoon, and fall recovery are readily seen using this technique. Also seen Gage. Geraghty and Miller, Inc. (1995) found that low flows at Charleston decreased are regions of increased low flows (white areas) with an associated lack of monsoon flows after 1965. Large winter events were more prevalent during the same period.

Jackson et al. (1987) evaluated trends in flows at the Charleston Gage from 1905 to 1985. Mean annual flows showed no significant trends over time, however, peak flows and mean annual low flows (lowest flow during any 1, 7, 30, and 90 day periods in a year) declined significantly. A similar significant declining trend in low flows was noted at the Palominas Gage. Geraghty and Miller, Inc. (1995) found that low flows at Charleston decreased substantially from 1905 to 1928, then increased until 1930. After 1930, the authors found that low flows generally declined. Koehler and Ball (1998) found that annual 7-day low flows at Charleston declined an average of 0.04 ± 0.01 cfs per year from 1935 to 1996. Winter base flows at Charleston declined steadily before 1951, but since then no trends were detected; winter base-flow correlates somewhat with meteorological events (Koehler and Ball 1998, Pool et al. 1998).

Interpretations of trends at Charleston before 1942 are questionable because the gage was at various locations in a six-mile reach before 1942 (Robert MacNish, University of Arizona, pers. comm., 1998). Analysis by Corell et al. (1996) demonstrate that base flow at Charleston declined from 9,470 acre feet (AF) per year in 1940 to 6,332 AF per year in 1951. Base flow declined again at Charleston from 6,583 AF per year in 1973 to 4,750 acre-feet per year in 1981. Jackson et al. (1987) note that at the Palominas Gage, "since 1950 it is common to have zero flow for both the 1-day and 7-day periods, and not uncommon to have zero flow for the 30-day period. Although none of the upper San Pedro River gages are considered accurate to within 15 percent for low flows, and as noted, analysis of trends at Charleston before 1942 is suspect, the overall declining trends in annual low flow are highly significant statistically (Jackson et al. 1987, Koehler and Ball 1998).

These trends are difficult to explain by fluctuations in precipitation alone (Jackson et al. 1987, Koehler and Ball 1998, Pool et al. 1998). Possible causes include: 1) changes in runoff from the watershed due to changes in watershed condition, 2) influences of near-stream groundwater pumping for agricultural purposes, 3) changes in water use in Mexico, 4) changes in water consumption by riparian vegetation along the river, and 5) groundwater pumping from the regional aquifer (Jackson et al. 1987, ASL 1994). Koehler and Ball (1998) conclude that there is little doubt that annual 7-day low flows are declining, but that evidence is lacking for a non-seasonal aquifer-wide phenomenon (such as groundwater pumping from the regional aquifer) being the sole cause of the decline. There is some preliminary evidence that low summer

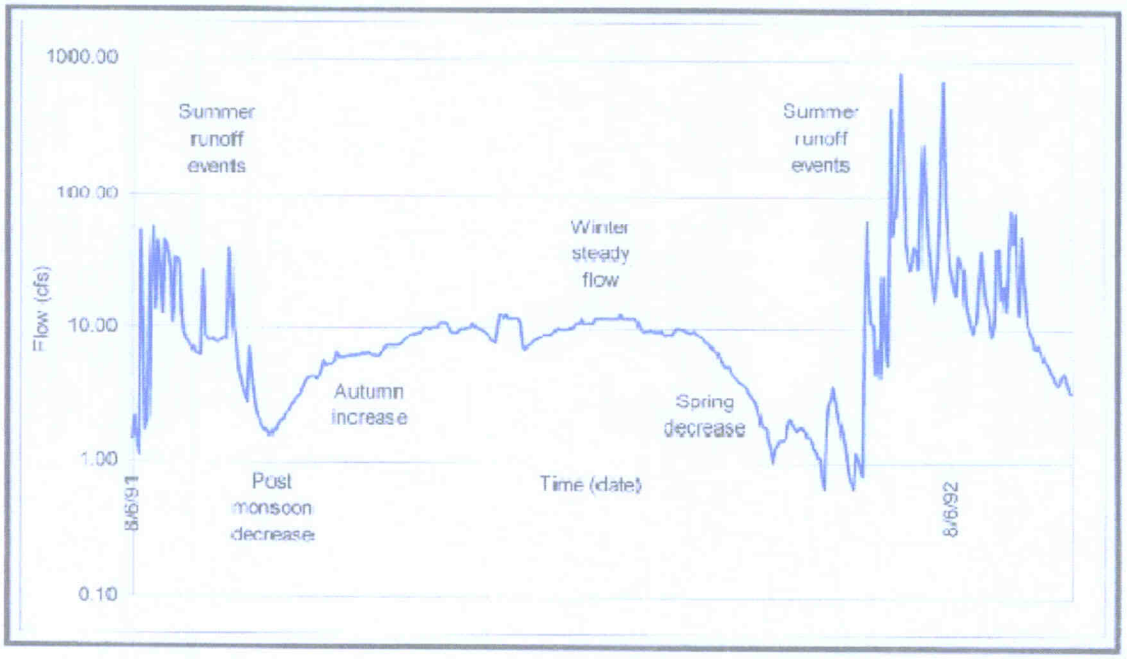

Figure 9. San Pedro River streamflow patterns for 1991 to 1992 at Charleston, Arizona (Koehler and Ball 1998).

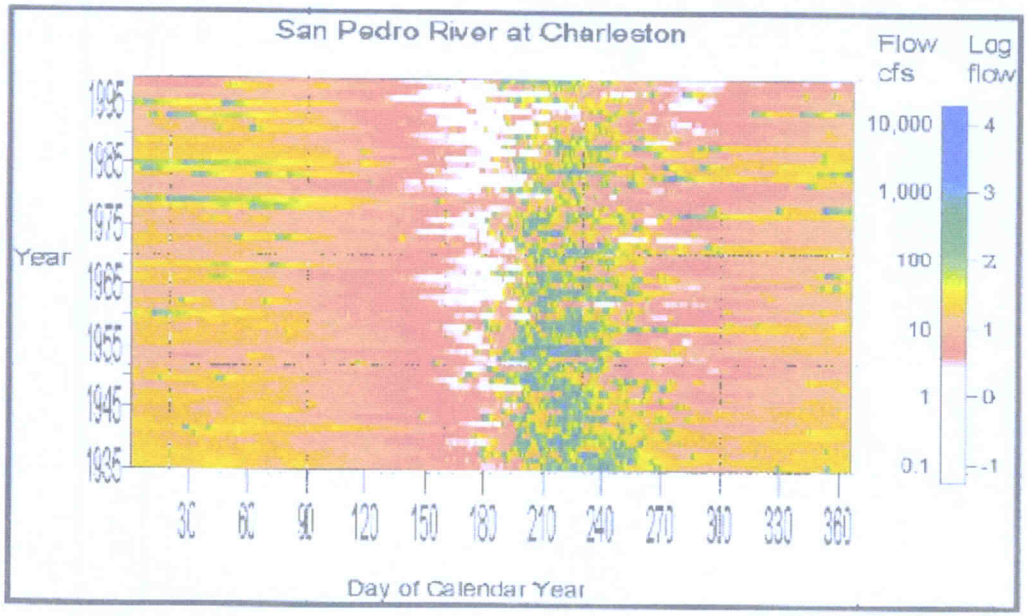

Figure 10. San Pedro at Charleston, Arizona, daily flow record 1935 to 1999 (Koehler and Ball 1998).

precipitation over the last 10 to 20 years has reduced recharge adjacent to the river and may have contributed to observed reduced base flow (Don Pool, USGS, pers. comm., 1999). Robert MacNish (pers. comm., 1998) notes that a diversion in Mexico, constructed in 1946 to 48, may be responsible for about a 0.5 cfs decline in base flow (about 25 percent of the drop in base flow at Charleston between 1942 and 1996).

Geraghty and Miller, Inc. (1995) found that declining flows since 1930 correlate well with the development of riparian woodlands, and that resulting increased evapotranspiration probably exacerbated seasonal and long-term declines in base flow. The riparian vegetation along the San Pedro River is the largest single consumer of groundwater in the subwatershed (San Pedro Expert Study Team 1999). Some have suggested that vegetation along the San Pedro River may need to be "managed to prevent reductions or loss of base flow. However, the assumption that water use by riparian vegetation may reduce or eliminate base flow ignores other hydrological benefits of riparian vegetation, including reducing flow velocity during flood events, thus facilitating capture of sediments and increased recharge of flood waters, reduced downcutting and incisement of the channel and associated draining of bank storage, and addition of woody debris to the river channel, which also slows flow velocity and allows greater recharge (DeBano et al. 1995). Also, attempts to increase stream flow or to salvage water by eliminating or reducing riparian vegetation has failed or were only marginally successful (see review in DeLoach 1991). For instance, eradication of saltcedar from 21,500 acres of the Pecos River in New Mexico has resulted in no detectable increase in river base flow (DeLoach 1991). Furthermore, "management or removal of riparian vegetation could have adverse effects on the water umbel, the southwestern willow flycatcher, and other species, and may be contrary to the Congressionally-designated purposes of the Riparian National Conservation Area.

The BLM established nine stream gages on the San Pedro and one gage on the Babocomari in the SPRNCA in 1987. Sharma et al. (1997) evaluated data from these gages, and correlations between these gages and the USGS gage at Charleston. Key findings from this report in regard to surface flows in the river included: 1) at low flows, the percentage of flow contributed by ground water discharge in the reach below Hereford has increased, possibly because of retirement of irrigated agriculture in the area, or as a result of diminished flows reaching Hereford from upstream; 2) there is a trend toward low flows becoming more frequent at Hereford - for instance, the number of days for which the flow was below 0.1 cfs was zero from 1987-1994, but from January-September 1995 the number of days below 0.1 cfs was seven; 3) inflows below Lewis Springs are diminished as a percentage of flow at the Charleston Gage, possibly as a result of increased water use by riparian vegetation or pumping outside of the SPRNCA; 4) low flows are becoming more frequent at the Charleston Bridge based on observed trends during 1987 to 1994; 5) flows at Charleston Hills have remained similar to discharge at Charleston Bridge during 1987 to 1994; there is evidence that there may be a slight reduction in percentage of flow lost to the groundwater system in this reach; and 6) at Fairbank, the loss of stream flow to the groundwater system has decreased, possibly due to less consumption by riparian vegetation, but low flows are increasingly common at this gage. Sharma et al. (1997) believed that the most likely cause of apparent decreased contribution of groundwater to stream flow in the Lewis Springs-Charleston Bridge reach was groundwater pumping outside of the SPRNCA.

Putman (1997) commented on the work by Sharma et al. (1997) that while it was reasonable in its statistical analysis of relationships between measurements sites and gage locations, it was not an analysis in depth of possible causes in change to streamflow. He went on to state that while pumping is one factor among many that influence streamflow (others include changes in riparian use, and species composition, climate and precipitation, Mexican water use, grazing and woodcutting), that it was inappropriate (for the authors) to assert changes seen in streamflow are due to pumping, phreatophyte growth, agricultural use or climatic factors without an in depth examination of these factors, which the report did not do (Putman, 1997).

In a draft report, MacNish (1998) evaluated the effects of possible changes in the climate, inflows from Mexico, water use by riparian vegetation, and extraction of groundwater on base flow. He concluded that climatic change, and reduced inflow from Mexico have had minor effects at most. Increased water use by riparian vegetation may be responsible for a little less than 25 percent of the observed decline in base flow at Charleston. As noted earlier, MacNish (pers. comm., 1998) notes that a diversion in Mexico, constructed in 1946 to 48, may be responsible for an approximate 0.5 cfs decline in base flow. However, MacNish (1998) concludes that the most important cause of diminished base flow is groundwater pumping, particularly in the southern portion of the basin where groundwater pumping was closer to the river, and that groundwater pumping in the Fort Huachuca and Sierra Vista area began impacting river base flow about 1990.

The assumption by MacNish that climate has a minor effect is not supported by Pool and Coes (1999), Koehler and Ball (1998), Harrington et al. (1992), or Swetnam and Betancourt, (1998). Pool and Coes (1999) state that variations in the seasonal distribution of precipitation resulted in important hydrologic effects adding possible changes in rainfall-runoff relations. Some suggested mechanisms at work include increased capture of wet-season runoff by increased vegetation, more frequent occurrence of low intensity rainfall, increased surface water diversions, and increased recharge resulting from increased groundwater withdrawals by riparian vegetation and by wells. Pool and Coes did not expand on the type of vegetation which increased capture of wet-season runoff.

While groundwater withdrawals close to the San Pedro are an important factor to understanding the decline in flows within the river, the suggestion by MacNish that decreases in base flow in the southern part of the basin from groundwater pumping as the most important cause ignores the other possibilities listed by Pool and Coes (1999). MacNish (1998) also writes that his opinion that the cone of depression around Fort Huachuca/Sierra Vista has reached the river cannot be stated as fact until other possible explanations for the data anomaly are first disproved. MacNish's opinion is not supported by Koehler and Ball (1998). They found that comparisons of adjusted correlation coefficient (r^2) values and root mean square (RMS) residuals showed no improvement when using higher order regressions over a simple regression. The linear trend from 1935 to 1999 was the best representation of the decline of annual 7-day low flows at Charleston and indicates that the decline has been an ongoing process. If MacNish's suggestion

that the cone had reached the river were correct, then the rate of decline in the 7-day annual low flows would be expected to increase over time. The linear trend does not support this suggestion.

The San Pedro Expert Study Team (1999) assessed effects of groundwater pumping on riparian habitats and migratory birds. They found that modeling of the groundwater system in the basin suggests the cone of depression in the Fort Huachuca and Sierra Vista area began to have significant effects on discharge to the river in the 1960s or 1970s. The model used by them indicated that after 30 years of pumping, discharge to the river was reduced to 30 percent of what it was before pumping. After 50 to 60 years of pumping the gradient to the river becomes flat and there is no longer flow to the river. If trends continue, gaining reaches of the river would become losing reaches. However, as groundwater elevation drops, riparian vegetation would decline resulting in less evapotranspiration, thus partially mitigating groundwater withdrawals. The authors do not state the model's baseline for when groundwater pumping started. Groundwater pumping was occurring in 1940, but significant withdrawals did not occur until the early 1960's (Vionnet and Maddock 1992). If the authors meant that groundwater pumping began in 1940, then 50 to 60 years after initiation of pumping would be 1990 to 2000. If initiation was in the early 1960's, then 50 to 60 years thereafter would be 2010 to 2020.

Groundwater pumping and land use upstream of the SPRNCA in Mexico affect flows as well. The best information available indicates that about 3,200 acres of farmland are irrigated in the Mexican portion of the San Pedro River basin (Watts et al. 1998). An estimated 9,600 AF of water is used per year to irrigate these crop lands. If this pumping were eliminated, median flows at Palominas would increase roughly by five cfs (3,500 AF per year [San Pedro Expert Study Team 1999]). An increase of 3,500 AF would represent about an eighteen percent increase in annual groundwater supplies in the Sierra Vista subwatershed. An estimated 2,300 AF per year is pumped for domestic uses in Cananea, Naco, and other smaller settlements. Pumping also occurs to support mining and a smelter at Cananea, but this pumping occurs on the southern edge of the watershed and may not impact base flows of the San Pedro River in the United States significantly (San Pedro Expert Study Team 1999).

The conclusions of the San Pedro Expert Study Team (1999), MacNish (1998), and Sharma et al. (1997) that groundwater pumping in the Fort Huachuca and Sierra Vista area has affected base flow have been questioned by some hydrologists. In a May 28, 1997, letter to Michael Shaughnessey, Fort Huachuca, hydrologist Jon Frenske, Army Corps of Engineers, believed the finding by Sharma et al. (1997) that groundwater pumping caused the observed changes in flow in the Lewis Springs-Charleston Bridge reach was "premature and unsupported by physical evidence and justification. In a July 1, 1998, memorandum (Fenske 1998), Mr. Fenske presented monitoring well data suggesting that from April 1995 to April 1998 the groundwater gradient along a transect from Sierra Vista to the San Pedro River at Charleston was reversed only within about 3.5 miles of Sierra Vista (i.e., the cone of depression had not reached the river in this area). However, in a letter to Mike Shaughnessey, Fort Huachuca, Mr. Fenske stated that several more years of data collection are needed to make conclusive statements based on the well data. In a June 6, 1997, letter to Dennis Sundie, ADWR, about the findings in Sharma et al. (1997), Frank Putman, ADWR, stated "it seems inappropriate to assert that changes seen in

stream flow are due to pumping, phreatophyte growth, agricultural use, or climatic factors without an in-depth examination of these factors, which this report does not do.

Summary of Groundwater Data

Groundwater elevation contour maps have been constructed for the Sierra Vista subwatershed from well data. These maps illustrate that groundwater enters the watershed in the form of mountain-front recharge, from the San Pedro River in losing reaches, and as groundwater flow moving northward from Mexico. Groundwater is transferred to the San Pedro River in gaining reaches, from evapotranspiration, groundwater pumping, and groundwater flow out of the basin to the north (ASL 1994). The aquifer is composed of a deep, regional aquifer that is mostly unconfined, except in some portions of the southern half of the subwatershed (ADWR 1994, Wynn and Gettings 1997).

The regional aquifer may contain an estimated 31.8 million AF of recoverable water in storage to a depth of 1,200 feet (ADWR 1991), although a recent report suggests the storage may be less due to the presence of extensive clay deposits (Wynn and Gettings 1997). Another published estimate of regional aquifer volume is available from the Cochise County Water Resources Inventory. In that study, the regional aquifer volume of the entire USPB is estimated to be 40.4 million AF (EEC 2002). This would reduce the estimated storage of recoverable water (<700 ft) within the Sierra Vista subwatershed to about 29.2 million AF. The reason for the large difference is the way Engineering and Environmental Consultants, Inc. (EEC) and ADWR each addressed the unconfined aquifer storage coefficient. The ADWR report assumed a constant 0.08 coefficient throughout the entire depth of the aquifer while EEC assumed a coefficient of 0.08 from the surface to 700 feet below the surface, then 0.03 from 700 feet to 1,200 feet below the surface. The basis for choosing the 700 feet cutoff is consistent with the 1977 Arizona Water Commission report where ten different basins in Southern Arizona were evaluated using depths of 700 and 1,200 feet for determining groundwater resources. The EEC approach is consistent with the Putman et al. (1988) report that states, "More water is available in the basin fill closer to the land surface because shallow fill is less compacted, more porous, and stores more water per unit volume. Deeper sediments have less porosity due to compaction from the weight of overlaying sediments, and thus store less water per unit volume . Other reports give the total ground water storage in the basin as 46.3 million AF (Arizona Water Commission 1977) and 56.7 million AF (ADWR 2002 *in* EEC 2002).

The floodplain aquifer is long, narrow, relatively shallow, and lies along the San Pedro River. Estimated water in storage on the floodplain aquifer ranges from 160,000 AF (depth of 60 ft) by ADWR (1991) to 237,000 AF (depth of 100 ft) by Putman et al. (1988). By using the young alluvium geologic unit with an assumed depth of 100 ft, EEC estimated 366,000 AF in the areas adjacent to the San Pedro River (EEC 2002). All of these studies used an aquifer storage coefficient of 0.12. Groundwater elevation in the floodplain aquifer is closely associated with river flow.

Based on a 1990 water budget modeling effort conducted by ADWR (1991), annual water supply into the Sierra Vista subwatershed was estimated at a basin total of 56,820 AF. About 28,850 AF were withdrawn for consumptive use, while 39,200 AF flowed out of the system as surface flow in the San Pedro River. Major contributions to basin-wide consumptive use included water use by riparian vegetation (~50 % or 14,425 AF), irrigation (~16% or 4,616 AF), and municipal and military (~23% or 6,635 AF).

As part of a study for the USPP, Fluid Solutions (2001) estimated the total (not consumptive) 2000 municipal, agricultural, recreational and domestic water use at 19,450 AF. Of this amount, 5,750 AF (29%) was used by Sierra Vista and 1,900 AF (10%) was used by Fort Huachuca. The Fort Huachuca value represents 7 percent of the basin-wide consumptive use listed by ADWR (1991). Other water users include Tombstone, Bisbee, Huachuca City, unincorporated area residents, and golf courses.

The ASL modeling demonstrated that use exceeded recharge by roughly 11,230 AF per year, which is the amount that is lost in storage each year (ASL 1994). An evaluation of the water budget showed the deficit was about 7,000 AF per year (San Pedro Expert Study Team 1999, Corell et al. 1996). The reduction in the deficit is due primarily to retirement of agricultural pumping. The San Pedro Expert Study Team (1999) estimated 500 to 900 acres of irrigated agriculture still remains in the subwatershed, using about 1,500 to 2,800 AF of water use per year, while Fluid Solutions (2001) estimated 5,179 AF was used for 917 acres of irrigated agriculture within the Sierra Vista subwatershed in 2000.

The San Pedro Expert Study Team (1999) estimated the water budget for the subwatershed through 2030 under a scenario in which the following projects would be implemented: 1) enhanced mountain front recharge of 1,000 acre-feet per year (corresponds to Fort Huachuca's proposed watershed improvements as described in SAIC (1998a), 2) continued water conservation programs at Fort Huachuca (increased recharge of 500 acre-feet per year), 3) sewage effluent recharge at Sierra Vista of 2,900 acre-feet per year, 4) water conservation and reduced pumping in domestic wells over a scenario without conservation (gain of 300 acre-feet per year), and retirement of all agriculture in the subwatershed (gain of 1,100 acre-feet per year). Assuming population growth projections of 73,900 and a consumptive use of 9,900 acre-feet per year in 2030, the deficit would be reduced to 6,770 acre-feet per year in 2030. If all irrigated agriculture in Mexico was eliminated, baseflow at Palominas would increase 3,500 acre-feet per year. Thus, the authors found that, even with implementation of a number of major mitigating measures, threats to the base flow of the river were not eliminated. The San Pedro Expert Study Team found that a means to maintain a viable riparian system was to shift the protected area southward and create a cross-border riparian protection zone, which would probably have to be coupled with water importation from the Douglas basin or the CAP. Other possible measures which either reduce consumptive use or increase water supply are described by the San Pedro Expert Study Team (1999), the Upper San Pedro Advisory Panel (1998), and the USPP report by Fluid Solutions (2001).

The San Pedro Expert Study Team (1999) may not have considered all potentially viable and feasible options for conserving water or increasing recharge. The Upper San Pedro Advisory Panel (1998) presented recommendations and findings to the International Commission for Environmental Cooperation. The Panel stated that "while achieving a water balance in the basin represents a significant challenge, we are confident that a focused campaign to save the river will succeed. The Upper San Pedro Partnership and Fort Huachuca also believe that the deficit can be erased and flow in the upper San Pedro River can be maintained.

The water budget produced for the BA gave different results. Water supply as inflow from Mexico and mountain front recharge is 16,750 AF per year. Withdrawals in the cities, unincorporated areas, Fort Huachuca, and for agriculture are 19,072 AF per year. Other "losses in the water budget are 350 AF per year from outflow in the river at Fairbank and evapotranspiration from riparian vegetation of 7,191 AF per year. The last item in the water budget is recharge from the Sierra Vista and Fort Huachuca effluent recharge projects, and recharge from area septic systems. The resulting balance is a deficit of 5,144 AF per year (ENRD 2002: Appendix K). The water budget produced for the BA uses the best available information and we accept the numbers and methods used to construct the water budget for the Sierra Vista subwatershed.

The Fort currently routes 1,013 AF of its effluent per year to a wastewater treatment plant. About 450 AF of the treated effluent is used to irrigate landscaping, of which 350 AF was used in 2001 on the Mountain View golf course. Historically, the remainder was routed to evaporation ponds on the East Range. These ponds were replaced with recharge basins and infrastructure for increased effluent and stormwater recharge. In addition, the Fort proposes to modernize the golf course irrigation system which uses treated effluent. The irrigation upgrade is estimated to reduce golf course use to about 245 AF per year, allowing an additional 100 AF per year to be recharged. The Fort recharge facility is located west of the clay deposit; thus effluent recharged at this locality would likely flow into the cone of depression (USFWS 1999a). The location of the recharge facility is located between the Sierra Vista and Fort Huachuca cone of depression and the Babocomari River based on maps from Cochise County Water Resources Inventory (EEC 2002).

Measures that have a potential to bring the water budget into balance include capture of up to 6,100 AF of ephemeral surface flows per year for use by Sierra Vista (ASL 1995), and retirement of agricultural lands north of the border (5,200 AF per year)(Fluid Solutions 2001). Other potential measures are moving the wells for Bisbee, Tombstone, and Naco out of the watershed and reducing water consumption by 10 percent in Sierra Vista. Bisbee plans to move its water treatment plant from the Yaqui basin to the San Pedro Basin. Implementation of these measures in addition to those described above would create a surplus of roughly 8,200 AF per year over the current situation. However, gains could be negated by increased population growth or new agricultural development and subsequent increased demand for water. Water use at Fort Huachuca is not expected to grow beyond that proposed (current water use is 1,655 AF)(ENRD 2002). Thus, if the mitigating measures described above were implemented and water was saved/recharged as estimated, the deficit would be roughly 3,306 AF per year in 2011. As

discussed by the San Pedro Expert Study Team (1999), additional base flow of up to 3,500 AF per year could be realized by eliminating agricultural pumping in Mexico. Other possible measures which either reduce consumptive use or increase water supply are described by the San Pedro Expert Study Team (1999), Upper San Pedro Advisory Panel (1998), the Upper San Pedro Partnership, and others.

An important point to bear in mind is that the water budget in Appendix K of the BA only covers the United States portion of the upper San Pedro basin. None of the natural inputs nor water use from agriculture (~9,600 AF [San Pedro Expert Study Team 1999]) and for Cananea are considered in that water budget. Any discussion of the upper San Pedro basin needs to include both the United States and Mexico parts of the basin. It is likely that with about 9,600 AF of use of ground water for irrigated agriculture and water for Cananea that the Mexico portion of the upper San Pedro basin is in a deficit also.

Groundwater pumping in excess of recharge has created local declines in groundwater elevation at Fort Huachuca and Sierra Vista and at Hereford/Palominas (Figure 11). "Cone(s) of depression in the vicinity of Fort Huachuca and Sierra Vista encompass about 7.5 square miles running in a northwest to southeast direction, paralleling the Huachuca Mountains for at least 15 miles from about the Babocomari River to south of Sierra Vista (ADWR 1994, Wynn and Gettings 1997, Schwartzman 1990).

Groundwater elevations have declined 20 to 90 feet in the Fort Huachuca and Sierra Vista cone of depression (Corell et al. 1996). Groundwater levels declined about 1.4 feet per year in this area from 1966 to 1986 (Putman et al. 1988). In the ADWR well survey of 1998, there was an average decline of two feet depending on location. Groundwater pumping at the north end of the cone of depression has affected flow patterns of the Babocomari River near northern Huachuca City and the Fort Huachuca East Range, where base flow is severely depleted or absent during the early summer dry season (Schwartzman 1990). Current groundwater drawdown along the Babocomari River is attributed to pumping by Huachuca City, Fort Huachuca, and City of Sierra Vista. Modeling predicts that pumping by Fort Huachuca and Sierra Vista will be responsible for 84 to 91 percent of the drawdown by 2015 (Schwartzman 1990).

Schwartzman (1990) comments that the possible effects of the cone of depression on the Babocomari River appear to be consistent with maps from the Cochise County Water Resources Inventory (EEC 2002). That report shows the cone of depression around Sierra Vista and Fort Huachuca has grown in size and depth when comparing 1970 to 2000 depths to groundwater contours. The cone has extended to the northwest away from the San Pedro River, along the front of the Huachuca Mountains in the Babocomari drainage. There appears to have been minimal extension of the cone of depression toward the San Pedro River itself (EEC 2002).

Another cone of depression in the Hereford-Palominas area is not as deep, but it underlies the San Pedro River and thus directly affects river flow. However, recent retirement of agricultural

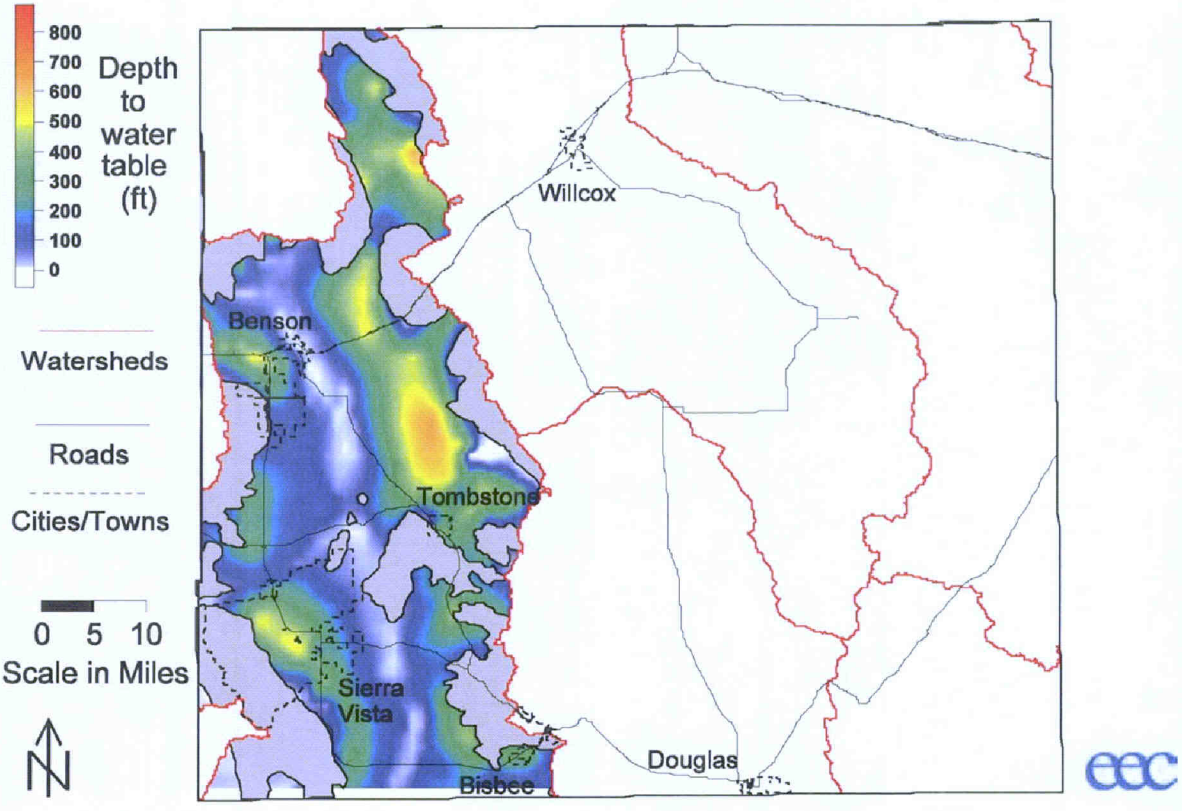

Figure 11. Depth to the water table in the upper San Pedro River basin, Arizona (EEC 2002).

pumping in the area has apparently allowed or contributed to some recovery of groundwater elevation (Sharma et al. 1997).

Most investigators do not believe the Fort Huachuca and Sierra Vista cone of depression has "reached the San Pedro River (ADWR 1991, 1994, ASL 1995, Fenske 1998, EEC 2002); however, the cone of depression captures water that would have reached the San Pedro River in predevelopment conditions (ADWR 1991, Corell et al. 1996). Indirect interference by the cone of depression will affect base flow by reducing the amount of groundwater that would have flowed into the river but does not remove water already in the river. In the case of direct interference (the cone "reaching the river) water is diverted from the river. The cone of depression will decrease the hydraulic head adjacent to the river before it reverses the flow of groundwater. However, there is uncertainty as to how much of the currently observed decline in base flow can be attributed to the reduced hydraulic head caused by the Fort Huachuca and Sierra Vista cone of depression. Koehler and Ball (1998) noted that winter 7-day flows did not show the same decline as annual (summer) 7-day declines. The authors reasoned if the cause of the annual

series decline was the result of a non-seasonal aquifer-wide phenomenon, such as the existing cone of depression around the Sierra Vista and Ft. Huachuca area, it would be reasonable to assume that this decline would be present regardless of the season. Conversely, if such a decline is not present in the winter dataset, it weakens the theory that the cone of depression is solely responsible for base flow decreases on the San Pedro River as appears to be the case.

Modeling by WESTEC (1996) estimated that agricultural users were responsible for 94% of the historic loss of river flow through 1988, while municipal and military users were only responsible for 6%. However, the authors did not calculate such estimates for present or future conditions. The San Pedro Expert Study Team (1999) speculated that river flow was affected by groundwater pumping as early as the 1960s or 1970s.

Agricultural usage of water in the subwatershed has declined in recent years due to retirement of croplands (ADWR 1994, San Pedro Expert Study Team 1999); however, one farm that was purchased by the Nature Conservancy was recently relocated to another site that is likely to have a greater impact on the hydrology of the river (San Pedro Expert Study Team 1999). Retirement of remaining agricultural lands is possible, as a means to either reduce water use or reduce conversion of agricultural lands to other uses such as urban development, which could result in adverse effects, including water use. Reprogramming of Land and Water Conservation Funds for acquisitions in the subwatershed as a part of the recent U.S.-Mexico binational initiative could hasten retirement of agricultural lands.

MacNish (1998) believes the Fort Huachuca and Sierra Vista cone of depression began affecting base flow about 1990, but that current declines are due primarily to pumping (mostly agricultural) in the Hereford/Palominas area. He believes that without mitigation, it is likely that the perennial reach of the San Pedro River north of Lewis Springs will become intermittent, if not ephemeral (lacking in base flow), perhaps within a decade.

Clay deposits occur in the San Pedro River Valley near Palominas and St. David (Putman et al. 1988). Recent information developed by Don Pool and his colleagues at USGS indicates clay deposits also occur along the west side of the river downslope from Sierra Vista that run in a north-south direction. The extent of the clay deposit is unknown, but the eastern edge of the deposit intersects the river about one to two miles south of Highway 90 (D. Pool, pers. comm., 1999, San Pedro Expert Study Team 1999). The location of the deposit suggests the reach in the vicinity of the Babocomari confluence would likely be the first area affected by groundwater pumping at Fort Huachuca and Sierra Vista, followed by the reach north of Charleston, and then the reach from Highway 90 to Charleston (Don Pool, pers. comm., 1999). This finding is supported by Pool and Coes 1999, Corell 1996, and ASL 1995. Although the hydraulic conductivity is low in the area of the deposit, Don Pool does not believe the clay deposit would slow the spread of the cone of depression or effects to river base flow. Of particular concern are wells that draw water from below the clay deposit, which would have the greatest potential to affect river base flow. Dr. Mark Gettings (pers. comm., USGS, 1998) has stated that the presence of an "intermediate conductor (clay deposit) would not prevent the cone of depression from spreading eastward to the San Pedro River. He said that a clay layer may slow the spread

of the cone, but depending on the nature of underlying substrates, a siphon effect under the clay layer could cause the cone of depression to spread very rapidly to the east. The deposit also limits the size of the groundwater reservoir, which could also speed enlargement of the cone of depression. South of Highway 90, the river probably flows, at least in part, atop the clay deposit, and flows probably reflect recharge near the river or inflow from upstream. In this reach, changes in the regional aquifer, such as groundwater pumping at Fort Huachuca and Sierra Vista, are less likely to affect base flow (Don Pool, pers. comm., 1999).

In summary, the information presented above emphasizes the speculative nature of the data and the conclusions drawn from that data in modeling efforts. The changes in the estimates of groundwater storage, the groundwater deficit, and the water budget for the subwatershed illustrate that fact. We believe that the water budget presented in the Fort's biological assessment represents the best available information and its use is appropriate.

Summary of Predictive Modeling

Modeling of groundwater relationships in the San Pedro basin began in the early 1970s with the development of a groundwater flow model by the Arizona Water Commission (1974). Recent modeling has been conducted by ADWR (Putman et al. 1988, ADWR 1991, 1994, Corell 1996, Corell et al. 1996), University of Arizona (Braun et al. 1992, Vionett and Maddock 1992), WESTEC (1994, 1996), Schwartzman (1990), and ASL (1995, 1998). Some reports model historic conditions (transient models); while others predict future conditions. Models developed by ADWR and the University of Arizona build on a model developed by USGS (Freethey 1982). Modeling by ASL was developed specifically to evaluate the effects of various effluent recharge scenarios on groundwater hydrology and river flow. These models provide the basis for predicting the effects of groundwater pumping on flows in the San Pedro River, or in the Babocomari River (Schwartzman 1990), under varying future scenarios, such as continued human population growth at current rates and patterns, elevated growth at Sierra Vista and Fort Huachuca, drought, and holding population static. The conclusions of recent modeling in regard to effects on river flow or extent of riparian vegetation under varying scenarios are presented in Table 9.

Table 9 summarizes the results of predictive modeling; however, many of these studies are comprehensive and detail many modeling outputs not presented here. To fully understand the mechanics, outputs, assumptions, and uncertainties of these models requires an in-depth review of each report. Such a review is beyond the scope of this opinion. Also, some of the models may need to be reviewed and revised in regard to new information about the presence of a clay deposit in the San Pedro River Valley, data from the two effluent recharge projects, and changes in water use in the subwatershed. However, some generalizations and commonalities can be drawn from the results of these various modeling exercises. A continuation of current growth patterns in the subwatershed without implementation of new recharge, water conservation, or other measures to reduce water use or enhance recharge will result in declining flows and loss of riparian vegetation on the San Pedro River (see scenarios [3] of WESTEC [1994], scenarios [A] and [D] of Braun et al. [1992], scenario [0] of ASL [1998] - Table 9).

Authors disagree as to when flows in the San Pedro may be significantly affected, but MacNish (1998) and the San Pedro Expert Study Team (1999) believe river flow has been affected for some time, while others believe flow may not be significantly affected for 40 years or more (ADWR 1991). The modeling efforts summarized in Table 9 estimate effects to the river as early as 2000 (WESTEC 1994, ASL 1998); or 2010 (Braun et al. 1992). Drought would exacerbate the effects of groundwater pumping on base-flow (Braun et al. 1992) and there is some evidence that low summer precipitation over the last 10 to 20 years has reduced recharge adjacent to the river and may have contributed to reduced observed base flow (Don Pool, pers. comm., 1999).

The University of Arizona Climatic Assessment Project for the Southwest report "Sensitivity of Water Resources in the USPB to Climatic Variability (Tschakert et al. 1999) examined climate as a factor for water resources management. Tschakert et al.(1999) state that within the Benson subwatershed, worst-case climate conditions (most severe five-year drought on record and area growth based on recent trends) could result in a three-fold increase in groundwater overdraft.

Within the Sierra Vista subwatershed similar worst-case conditions could cause the current overdraft to increase four-fold. Population projections are based on actual growth rates from 1990 to 1998, but no breakout for growth attributable to Fort Huachuca. Climate variability and climate change are also considerations when managing rare species and because climate influences ecosystem processes (Swetnam and Betancourt 1998, Scalero et al. 2001).

Interestingly, even if all groundwater pumping in Sierra Vista and Fort Huachuca ceased and agricultural pumping rates were fixed at 1988 levels, modeling showed that average annual flows would still decline at Charleston, Fairbank, and at Benson Narrows (WESTEC 1994). This would occur because over time the cone of depression is expected to flatten out, even if the volume of the cone is decreasing. As it flattens out, it could capture the base flow of the San Pedro River (C. Rovey, WESTEC, pers. comm., 1995). This indicates that balancing water use and water supply may not be enough to prevent capture of river base flow by the cone of depression. Effluent or other enhanced recharge next to the river could perhaps establish a groundwater mound between the river and the pumping center and halt or slow the expansion of the cone of depression (ASL 1998). Temporarily pumping groundwater directly into the river may also mitigate effects of an expanding cone of depression, at least in the short term (San Pedro Expert Study Team 1999).

Table 9. Summary of groundwater and other modeling efforts in the upper San Pedro River basin, Arizona, that predicted future river flow or extent of riparian vegetation.

Scenario	Source Effects on upper San Pedro River flows or riparian vegetation
WESTEC (1994): This effort used the MODFLOW model with modifications by the authors. Outputs are annual average flows, which lump flood flows with base flows. Flows are modeled from 1988-2088.	
(1) No pumping at the Fort/Sierra Vista after 1988, pumping in rural/agricultural areas at 1988 rates	Annual average flows decline at Charleston (42.7 cfs in 1988 to 41.5 cfs in 2088), at Fairbank (44.8 cfs in 1988, 43.6 cfs in 2088), at Benson Narrows (42.0 cfs in 1988 to 39.6 cfs in 2088)
(2) Very little pumping at the Fort/Sierra Vista, pumping in rural/agricultural areas at 1988 rates	Annual average flows decline at Charleston (42.7 cfs in 1988 to 40.9 cfs in 2088), at Fairbank (44.8 cfs in 1988, 43.0 in 2088), and at Benson Narrows (42.0 cfs in 1988 to 39.0 cfs in 2088)
(3) Same as 2nd scenario, but pumping in Fort/Sierra Vista area at 100% of projected demand if no expansion of the Fort occurs	Annual average flow decline at Charleston (42.7 cfs in 1988 to 40.0 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 42.1 cfs in 2088) and at Benson Narrows (42.0 cfs in 1988 to 38.1 cfs in 2088)
(4) Same as 2nd scenario but assumes a new command is established at the Fort	Annual average flows decline at Charleston (42.7 cfs in 1988 to 39.9 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 41.9 cfs in 2088), and at Benson Narrows (42.0 cfs in 1988 to 37.9 cfs in 2088)
(5) Same as 4th scenario but assumes effluent recharge	Annual average flows increase at Charleston (42.7 cfs in 1988 to 42.8 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 44.9 in 2088), and at Benson Narrow flows decreased (42.0 cfs in 1988 to 40.8 cfs in 2088)
(6) Same as 5th scenario, but pumping locations in the Sierra Vista area are spread over a larger area	Annual average flows increase at Charleston (42.7 in 1988 to 43.6 in 2088), at Fairbank (44.8 cfs in 1988 to 45.7 cfs in 2088), and at Benson Narrows flows decreased (42.0 cfs in 1988 to 41.6 in 2088

Scenario	Source Effects on upper San Pedro River flows or riparian vegetation
(7) Same as 5th scenario, but assumes greater effluent recharge	Annual average flows increased at Charleston (42.7 cfs in 1988 to 46.8 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 49.0 cfs in 2088), and at Benson Narrows (42.0 cfs in 1988 to 44.7 cfs in 2088)
(8) Pumping in the Sierra Vista subwatershed increases at 3% per year, no effluent recharge	Annual average flows decrease at Charleston (42.7 cfs in 1988 to 34.3 cfs in 2088), at Fairbank (44.8 cfs in 1988 to 36.3 cfs in 2088), and at Benson Narrows (42.0 cfs to 22.7 cfs in 2088)
(9) Same as scenario 8, but assumes effluent is recharged at the Sierra Vista water treatment plan, and recharge increases at 3% per year	Annual average flow decrease at Charleston (42.7 cfs in 1988 to 36.3 cfs in 2088), and Fairbank (44.8 cfs in 1988 to 38.3 cfs in 2088), and at Benson Narrows (42.0 cfs in 1988 to 23.5 cfs in 2088)
Corell (1996): This modeling effort used the ADWR Sierra Vista subwatershed upper San Pedro Basin groundwater flow model. Population growth projections were provided by the Arizona Department of Economic Security. In scenarios with effluent recharge, recharge is assumed to occur at the Sierra Vista water treatment plant.	
(0) Assumes no population growth in the Sierra Vista subwatershed after 1990, agricultural pumping in the Palominas/Hereford area is phased out by 2000, no effluent recharge	Stream flow (base flow) increases at Palominas (1.13 cfs in 1990 to 2.2 cfs in 2030), at Charleston (4.81 cfs in 1990 to 5.74 cfs in 2030), and decreases at Tombstone gage (8.32 cfs in 1990 to 7.86 cfs in 2030), and on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.46 cfs in 2030).
(1.1) Assumes growth from current population of 51,400 to 73,870 in 2030, effluent recharge of 2,994 acre-feet/yr, agricultural pumping in the Palominas/Hereford area phased out by 2000.	Stream flow increases at Palominas (1.13 cfs in 1990 to 2.19 cfs in 2030), at Charleston (4.81 cfs in 1990 to 6.25 cfs in 2030), at Tombstone gage (8.32 cfs in 1990 to 8.46 cfs in 2030), and declines on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)
(1.2) same as 1.1, but assumes agricultural pumpage in Palominas/Hereford area at 1624 acre-feet/yr	Stream flow increases at Palominas (1.13 cfs in 1990 to 1.63 in 2030), decreases at Charleston (4.81 cfs in 1990 to 4.74 cfs in 2030), and decreases on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)

Source Scenario	Effects on upper San Pedro River flows or riparian vegetation
(2) Population increases to 68,330 in 2030, effluent recharge at 2,994 acre-feet/yr, agricultural pumping in the Hereford/Palominas area phased out by 2000	Stream flow increases at Palominas (1.13 cfs in 1990 to 2.19 cfs in 2030), at Charleston (4.81 cfs in 1990 to 6.25 cfs in 2030), and declines on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)
(3) Population increases to 77,724 in 2030, no effluent recharge, agricultural pumping in the Palominas/Hereford area phased out by 2000, evapotranspiration increases to 10,000 acre-feet/yr	Stream flow increases at Palominas (1.13 cfs in 1990 to 1.81 cfs in 2030), decreases at Charleston (4.81 cfs in 1990 to 4.56 cfs in 2030), at Tombstone gage (8.32 cfs in 1990 to 6.4 cfs in 2030), and on Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.35 cfs in 2030).
Braun et al. (1992): This modeling effort used the model "WATERBUD" developed by a team of hydrologists at the University of Arizona. The model has many outputs. Only scenarios examining simulated future changes in riparian acreage are summarized here.	
(A) Effects of water management in the Sierra Vista subwatershed are modeled in regard to effects on acreage of riparian vegetation. In scenario A, population growth patterns are assumed to remain static, and over 150 parameters are modeled at default settings, which approximate conditions in 1989-90. Under scenario A, various water management policies to curb use or enhance recharge are evaluated.	Increases in riparian acreage of up to 100 acres by 2010 occur under policies that result in increased river discharge and retirement of agricultural acreage. Such policies include enforcing a ceiling on domestic water consumption, requiring minimum irrigation efficiencies, retirement of irrigation water rights, and placing a pump tax on well withdrawals. Decreased riparian acreage of less than 100 acres by 2010 results from other policies, including maximal water conservation, and recharging effluent and cloud seeding. Without water policies, riparian acreage declines by about 60 acres.
(D) Population and agricultural water use are identical to scenario A, but this scenario assumes a worst case drought, which is the hottest and driest recorded in the previous 20 years.	Half of the policy scenarios result in decreased riparian acreage of about100-250 acres, the other half result in modest gains of less than 50 acres by 2010. Policies leading to increased acreage include a pump tax and a variant of enforcing a ceiling on domestic water use, requiring minimum irrigation efficiencies, and buy outs of irrigation water rights. Other variants of this, cloud seeding and effluent recharge, and maximal water conservation lead to declines in riparian acreage. Without these water policies, riparian acreage declines about 225 acres by 2010.

Source

Scenario	Effects on upper San Pedro River flows or riparian vegetation
ASL Hydrologic & Environmental Services (1998): Using the model "MODFLOW", river base flow is modeled through 2040 under three scenarios: no recharge, and "partial" and "full" recharge at the Sierra Vista wastewater treatment plant. All scenarios assume agriculture pumping at 1,624 AF/year, population growth based on latest estimates from AZ Department of Economic Security, and evapotranspiration remains at 1990 levels.	
(0) No effluent recharge in Sierra Vista	Base flow at Hereford remains near zero through 2040. At the Charleston, base flow declines from 4.95 cfs in 1990 to 3.75 cfs in 2040. At Fairbank, base flow declines from 6.57 cfs in 1990 to 4.34 cfs in 2040. Declines begin by 2000. Base flows decline from a point between Hereford and Lewis Springs downstream to at least Fairbank. Small increases in base flow occur from the international boundary to near Hereford. Declines in base flow begin by 2000.
(1) 1,516 acre-feet would be recharged per year from 2000-2010 and 1,762 acre-feet per year from 2010-2020. No recharge would occur after 2020.	Base flow increases at Hereford remains near zero through 2040. At Charleston gage, base flow declines from 4.95 cfs in 1990 to 4.00 cfs in 2040. At Fairbank Gage base flow decreases from 6.57 cfs in 1990 to 4.64 cfs in 2040. Changes in flow begin by 2000. Base flows decline from a point between Hereford and Lewis Springs downstream to at least Fairbank. Small increases in base flow occur from the international boundary to near Hereford.
(2) Recharge rates would increase from 2,336 acre-feet in 2000-2010 to 3,647 AF in 2030-2040.	Base flow at Hereford remains near zero from 2000-2040. At Charleston Gage base flow increases from 4.95 cfs in 1990 to 5.46 cfs in 2040. At Fairbank Gage, base flow decreases from 6.57 cfs in 1990 to 6.13 cfs in 2040. Changes in flow begin by 2000. Small increases in base flow occur from the international boundary to near Hereford and in the Lewis Springs-Charleston reach.

Source

Scenario	Effects on upper San Pedro River flows or riparian vegetation
Steinitz et al. (2000): Alternative futures for the upper San Pedro River basin: Arizona, and U.S.A., and Sonora, Mexico. Effort looked at various scenarios over 20 years, though models were carried beyond 20 years. Hydrological models used are unknown. All 10 scenarios had deficit ground water pumping. Flow in the river was maintained until 2020. But when the models were continued beyond 2020, all scenarios caused major impacts to the river.	
(Test 1) PLANS vs. PLANS 1 compares plans and forecast population with doubled population. Gives the same result as extending the population growth another 20 years to 2040, assuming unchanged plans.)	The most significant regional difference in impact is on groundwater. Despite the assumption of reduced municipal and industrial water demand per capita, the increased population in PLANS 1 overwhelms the assumed water savings, and the groundwater level continues its accelerated decline.
(Test 2) PLANS vs. PLANS 2 compares the current plans and population assumptions for Arizona and Sonora with increased growth in Sonora, doubling Cananea and its associated mining.	Due to increased groundwater pumping and water use, there is an accelerated rate of water table lowering.
(Test 3) PLANS vs. PLANS 3 compares the current plans and population assumptions for Arizona and Sonora with policies that guide Arizona's future development into four zones, Sierra Vista, Benson, Tombstone, and Bisbee. Growth is directed mainly by the provision of infrastructure in advance of development, but development outside the four zones is not prohibited.	Ground water for municipal use is less in PLANS 3. However, there is still a groundwater deficit with both scenarios.
(Test 4) CONSTRAINED vs. CONSTRAINED 1 assesses the effect of doubling the on-base population of Fort Huachuca when policies favoring constrained development are in force. The effluent recharge plant is not included in the CONSTRAINED Alternative Futures.	More ground water is used in constrained 1, but both scenarios lead to decreased water tables.

Scenario	Source Effects on upper San Pedro River flows or riparian vegetation
(Test 5) CONSTRAINED vs. CONSTRAINED 2 assesses the effect of closing Fort Huachuca and dividing its land between conservation and development. Because it had the lowest forecast population, CONSTRAINED 2 is expected to have the lowest impact on hydrology.	Although it had the lowest hydrological impacts as expected, CONSTRAINED 2 continues to cause lowering of the water table.
(Test 6) OPEN vs. OPEN 1 assesses the effect of closing Fort Huachuca when development controls are reduced, and population growth in Arizona is higher than forecast.	All OPEN scenarios result in higher groundwater use because of greater populations and less water conservation. OPEN 1 has more water use then OPEN because of more population growth.
(Test 7) OPEN vs. OPEN 2 assesses the effect of greatest population growth when development controls are reduced. The population in Arizona, Fort Huachuca, and Cananea double.	As anticipated, OPEN 2 produces by far the highest impacts on hydrology, with the most rapid depletion of groundwater due mainly to increases in municipal and industrial water use.
Schwartzman (1990) *This study used the Theis equation to predict the effects of groundwater pumping on the Babocomari River. The model assumes that the regional aquifer is an isotropic homogeneous aquifer with an initially flat water table, infinite aerial extent, and no sinks or sources besides the pumping wells. The model assumes that the relative proportions of pumping between individual water users remains constant over the next 100 years. Pumping rates were based on existing conditions and remain constant throughout the 100-year period.*	
Continuation of pumping at current rates in wells at Huachuca City (3 wells), Fort Huachuca (>7 wells), and City of Sierra Vista (>5 wells)	Groundwater declines in an area of considerable riparian vegetation downstream of Huachuca City by an estimated 5.8-11.5 feet in 50 years and 8.6-20.5 feet in 100 years. Groundwater decline is attributable mostly to pumping by Fort Huachuca and City of Sierra Vista.

Although there were problems with the process used by the Alternative Futures effort (Steinitz et al. 2000), and a final report has not been completed, their modeling gave results similar to other modeling (Table 9). The purpose of the alternative futures project was to analyze how different urban growth and change scenarios could influence the basin's hydrologic and biologic resources. Three different groups of scenarios were modeled to 2020 and beyond.

The "plans or scenarios were based on existing planning documents and land use practices. The four scenarios analyze different population numbers and patterns. The "constrained scenarios explore population growth that is lower than forecast with tightly controlled development zones. The three scenarios look at doubling the Fort's population and closing the Fort. The final scenarios are the three "open models. The open scenarios assumed greater than predicted population increases with low density development throughout the basin. The open models look at the same options as the constrained models.

Model results indicated that urbanization and agriculture are the major impacts affecting the upper San Pedro basin and both direct and indirect effects modify the basin's hydrological regime. All 10 models and the comparative tests that were (Table 9), showed that deficit ground water pumping would continue until 2020. However, there is great variation among the models, ranging from a 20-year ground water deficit of about 14,000 AF for the C2 model to about 53,000 AF for the O2 model.

All alternatives eventually result in lowering of the water table under Sierra Vista and Fort Huachuca by at least 33 ft. Alternatives that curtail irrigated agriculture result in a higher water table north of St. David. They found that irrigated agriculture had the greatest effect on basin hydrology (Steinitz et al. 2000).

Their finding regarding Ft. Huachuca was interesting. They modeled three choices for Fort Huachuca: continuing as it was in 2000, doubling in size, and closing. They found that the variance in hydrological and biological impacts associated with Fort Huachuca are small when they are compared with urbanization and irrigated agriculture (Steinitz et al. 2000).

SAIC (1998a) maintains that studies and models that conclude that groundwater pumping in the Fort Huachuca area will, in time, result in reduced flows on the San Pedro River do not take into account recent findings of Wynn and Gettings (1997) and Don Pool. SAIC contends that these studies show the cone of depression is at least somewhat isolated from the San Pedro River, and therefore continued pumping from the cone in excess of recharge is less likely to affect the San Pedro River than suggested by earlier studies. As discussed above, this may be true for the reach from Hereford to Highway 90, where the clay deposit underlies portions of the river, but flows downstream of Highway 90, and particularly in the vicinity of the Babocomari confluence, are quite vulnerable to groundwater pumping at Fort Huachuca and Sierra Vista.

The modeling summarized in Table 9 make it clear that several water management options are available that have great potential to mitigate or eliminate adverse effects on river flow and

riparian vegetation, at least over the next 15 to 100 years. Recommendations for reducing the deficit in the water budget can be found in reports by the San Pedro Expert Study Team (1999), the Advisory Panel on the Upper San Pedro River (1998)(also see Commission for Environmental Cooperation 1999), the recommendations of a local consortium of water users that was known as the Water Issues Group (WIG), recommendations of the Upper San Pedro Partnership, the draft Cochise County Comprehensive Plan, and the City of Sierra Vista's General Development Plan.

One of the most effective means to reduce effects on the river is to retire agricultural pumping (compare scenarios 1.1 and 1.2 of Corell [1996], and scenarios [A] and [D] of Braun et al. [1992]). Modeling by WESTEC (1996) estimates that agricultural users were responsible for 94 percent of the historic loss of river flow through 1988, while municipal and military users were only responsible for six percent. Retirement of agricultural pumping in the SPRNCA has resulted in apparent increases in groundwater discharge to the river below Hereford Bridge (Sharma et al. 1997)(although the increases are surprisingly small), and modeling suggests that cessation of agricultural pumping is one of the most important potential water management tools (Table 9). The San Pedro Expert Study Team (1999) found that 1,100 acre-feet could be saved per year by retiring the remaining 500 to 900 acres of irrigated agriculture in the subwatershed. The Fluid Solutions analysis showed that irrigated agriculture water use in the Sierra Vista subwatershed for the year 2000 was 5,179 AF. This does not include an estimated 800 AF of groundwater used on area golf courses (Fluid Solutions 2001).

Irrigated agriculture in Mexico is estimated to use 9,600 AF annually (San Pedro Expert Study Team 1999). Elimination of the groundwater use associated with Mexican agriculture could increase base flow at Palominas by 3,500 AF (San Pedro Expert Study Team 1999). A significant threat to the river is possible as a result of future development of new agriculture in the subwatershed or upstream in Mexico. Purchase of agricultural development rights, an Arizona state government designation of an active management area (AMA) or irrigation non-expansion area (INA) which prohibit any new irrigation uses, or other such mechanisms could be used to reduce this type of water use. If put into place, existing irrigated areas would be grandfathered but no new irrigated areas would be allowed. If the grandfathered areas were retired, existing water use would be reduced.

Effluent recharge by the Fort, City of Sierra Vista, or others in the subwatershed could also be an important means to mitigate groundwater pumping, at least in the short term. In scenarios evaluated by ASL (1998), recharge of effluent at the City's wastewater treatment plant resulted in increased base flow over the no recharge scenario in a reach from about Highway 90 downstream to at least Fairbank (Table 9). ASL's "partial recharge scenario corresponds to a project under a 1996 cooperative agreement among the City, Bureau of Reclamation, and the Arizona Water Protection Fund that calls for the City to recharge all of the effluent it owns and controls from 2000 through 2020. Under this scenario base flow remains essentially the same from 2000 to 2020; whereas in the no recharge scenario, base flow declines by as much as ~0.8 cfs between 2000 and 2020. Under the "full recharge scenario, all effluent received at the wastewater treatment plant would be recharged through 2040, including all of the Castle and

Cooke (a local developer and water company) effluent. This goes beyond the current proposal. However, under the "full recharge scenario, base flow increases over the year 2000 conditions in the reach from Lewis Springs to upstream of Charleston by as much as 0.5 cfs through 2040. Base flows remain essentially unchanged in the Fairbank area (ASL 1998). The Sierra Vista effluent facility became operational in May 2002 (ENRD 2002).

Because of the recharge from this project, an examination of the underlying assumptions of the model and the input variables is warranted to determine if the model output may provide a reasonable prediction of future conditions. In their "partial recharge scenario, which corresponds to current plans, ASL (1998) assumed 1,516 acre-feet would be recharged per year from 2000 to 2010 and 1,762 acre-feet per year from 2010 to 2020. No effluent recharge would occur after 2020. All recharge controlled by the City of Sierra Vista would be recharged. Currently about 25 percent of effluent entering the wastewater plant originates at Castle and Cooke. If Castle and Cooke constructed the infrastructure, it could take delivery of its effluent and use it for irrigating golf courses or other uses. Castle and Cooke has no intention of treating their own wastewater. The City intends to have new developments be serviced by their treatment plant (Tom Cochran, Ft. Huachuca, pers. comm., 2002). In the partial recharge scenario, ASL assumed that effluent from Castle and Cooke would not be available for recharge, and that 50 percent of new development in Sierra Vista would occur on Castle and Cooke lands. If the infrastructure is not built, and Castle and Cooke does not take delivery of its effluent, then effluent available for recharge would be greater than that modeled. Thus, the scenario is conservative in regard to effluent provided by Castle and Cooke, if 50 percent or less of new development in Sierra Vista occurs on Castle and Cooke lands. Population growth projections for the subwatershed were provided by the Arizona Department of Economic Security and are based on May 1997 projections, which are higher than 2000 census projections. These projections are similar to those used by Corell (1996) and the San Pedro Expert Study Team (1999). The model also assumes 1,624 acre-feet of agricultural pumping per year in the subwatershed, which is similar to estimated current agricultural pumping (Corell et al. 1996, San Pedro Expert Study Team 1999), but lower than the estimate of 5,179 AF used by Fluid Solutions (2001). Thus, in regard to population projections and agricultural pumping, the model is not realistic. No other recharge or reuse facilities are assumed to exist in the subwatershed through 2040, although Fort Huachuca has reconstructed their effluent ponds to increase recharge, as discussed below. Huachuca City may send its effluent to the Fort Huachuca recharge facility. Thus, the model is conservative in regard to future recharge efforts. The model also assumes evapotranspiration remains at the rate that ADWR (1991) assumed was occurring in 1990 (8,000 AF per year). This is similar to the evapotranspiration estimated by the San Pedro Expert Study Team (1999)(7,900 AF per year). In summary, ASL's partial recharge modeling scenario could be considered conservative in terms of the amount of effluent that would be recharged, overestimates population growth, and underestimates agricultural pumping, limiting the usefulness of the modeling scenarios.

Uncertainty about the accuracy of input variables and future conditions suggests the model should be used cautiously. There is much uncertainty in the evapotranspiration estimate, particularly when projected into the future. If groundwater declines in the floodplain aquifer, evapotranspiration would be expected to decline (ADWR 1994, Stromberg et al. 1996). BLM

and Arizona Game and Fish Department have reestablished beavers to the SPRNCA, which may cause additional changes in riparian vegetation communities and evapotranspiration rates. Because evapotranspiration is a relatively large percentage of consumptive water use in the subwatershed [~30 percent (San Pedro Expert Study Team 1999)], relatively small errors in estimating this variable would translate into significant changes in the model output. Goodrick et al. (1998) calculated that evapotranspiration from Lewis Springs to 4 miles north of Fairbank was roughly 7,040 acre-feet per year, suggesting that 8,000 acre-feet may be an underestimate for the subwatershed. However, 86 percent of the 7,040 acre-feet were attributed to mesquite evapotranspiration, whereas, other research suggests mesquite on the upper San Pedro River may use less groundwater than previously thought (Scott et al. 1998, ARS data).

Other model inputs are also uncertain. Changes in water use in Mexico (San Pedro Expert Study Team 1999), possible future long-term drought or wet periods (Braun et al. 1992, Tschakert et al. 1999), changes in the watershed brought about by fire or changing grazing practices, the fate of Fort Huachuca in future base relocation and closure actions, and other elements of uncertainty could all be very important in shaping the water budget in the future. Furthermore, recharging aquifers by way of recharge basins is not always successful; basins clog with sediments and microorganisms, requiring regular maintenance. It is unknown how long such facilities can be feasibly operated. ASL (1998) notes that their simulations "are not meant to be a precise prediction of what will happen in the future, but more a qualitative representation of how various pumping and recharge scenarios may affect the groundwater and surface water systems in the future. The model is probably most valuable in estimating relative differences among alternative futures (i.e., is one project alternative better than another at maintaining base flow), rather than determining absolute future conditions.

There are additional points to consider in evaluating whether the model output corresponds to a reasonable estimate of future conditions. Corell (1996), using the same model as ASL (1998), found that in the later years of the simulations (which were run through 2030), model cells at the base of the Huachuca Mountains were pumped dry. The model shut down pumping in those cells and thus pumping was undersimulated in the later years by 5 to 8 percent depending on the scenario. In other words, the model reduced pumping in the later years by 5 to 8 percent over what was put into the model. This same problem occurred in the model when used by ASL (Steve Lacey, Fluid Solutions, pers. comm., 1998). The result is that somewhat less pumpage was simulated than indicated by the input variables and thus the effects on river base flow may have been underestimated in later years. The underestimate may be small due to the relatively small reduction in pumpage (5-8%), and the distance from the San Pedro River to the cells that went dry (Huachuca Mountain front). However, the water would be needed to be attained from somewhere, and the replacement pumping would more than likely be closer to the river. Another possible problem is that the model assumes recharge begins in 2000. However, full operation did not begin until 2002.

Although the above discussion indicates the model should be used cautiously, the presence of a clay deposit in the vicinity of the proposed facility injects additional uncertainty into the results of the ASL modeling effort. The proposed site of the recharge project lies atop the clay deposit,

which according to Don Pool could result in the recharged effluent emerging as spring flow at Murray Spring or other nearby springs. The model recognizes the presence of finer materials in the area, as evidenced by lower transmissivity values in these cells. However, the spring flow would be subject to evaporation and transpiration, which would reduce water available to recharge the aquifer (but evaporation and transpiration would probably amount to no more than a few hundred AF per year). The clay deposit also has the potential to alter the effluent flow path, possibly increasing or decreasing the amount of recharge that flows to the river.

Regardless of this uncertainty, the effluent recharge project is expected to be a critical link in maintaining base flow in the San Pedro River, at least in the near term. Despite the clay deposit, the project should increase the flow of groundwater to the river and reduce the deficit in the water budget. The facility should delay effects of groundwater pumping on water umbel habitat in the San Pedro River and provide additional time to develop and implement other water management strategies. These other strategies would hopefully emerge in the Upper San Pedro Partnership's Conservation Plan.

Measures other than effluent recharge that lead to increased base flow or increases in riparian acreage under the various modeling efforts include a pump tax, enforcing a ceiling on domestic water use, requiring minimum irrigation efficiencies, authorizing buy-outs of irrigation water rights (Braun et al. 1992), capture and use of surface flows in the watershed outside of the San Pedro River (ASL 1995), and reduced pumping of groundwater (WESTEC 1994, Corell 1996). The San Pedro Expert Study Team (1999) and Advisory Panel on the Upper San Pedro Initiative (1998) also suggest pumping groundwater directly into the river during extreme drought, housing density restrictions, reduction of irrigated agriculture in Mexico, importation of water from another basin (Douglas basin or from the Central Arizona Project), various water conservation measures, and regulatory mechanisms, such as establishment of an AMA or irrigation non-expansion areas under the Arizona Groundwater Management Act, and pursuing water rights issues under the Gila River adjudication.

As in the previous section, the information presented in this section emphasizes the speculative nature of the data. The estimates used for the various models rely on a multitude of assumptions; change in any of the numbers used can cause widely varying differences in the model results. This section illustrates that reducing groundwater pumping for irrigated agriculture can have the largest beneficial effect on flows in the San Pedro River. There are conflicting model results and interpretation on if groundwater pumping in the subwatershed has already affected flow in the river, if it ever will, and what effects there may be if pumping does reduce flow in the San Pedro River.

Fort Huachuca Localities of the Huachuca Water Umbel

Warren and Reichenbacher (1991) surveyed Fort Huachuca for rare plant species from June to September 1989, and located Huachuca water umbel in upper Garden Canyon and at Sawmill Spring. Microhabitats where the plants were found were low-gradient cienega habitats with apparently permanent water and stable, non-eroded channels. Sheridan Stone and Jim Hessil of

the Fort Huachuca Wildlife Office have since located the water umbel at three additional localities in the upper and middle reaches of Garden Canyon and near McClure Spring in McClure Canyon (Haas and Frye 1997, Jim Hessil, pers. comm. 1998). The species may occur at other wet, boggy areas along Garden Canyon, as well. The Huachuca water umbel also occurs off-post on the west slope of the Huachuca Mountains in Scotia and Sunnyside canyons, and in Bear Canyon and its tributaries. Populations in upper Scotia Canyon are located within one mile of the western boundary (Gate 7) of Fort Huachuca.

There are eight populations of this subspecies on Fort Huachuca in Garden, Sawmill, and McClure Canyons within the South Range of the installation (Figure 12)(EEC 2000a, 2001a). It is not known how long these populations have existed in these locations, however, water umbel has been documented in Garden Canyon since 1958 and in Sawmill Canyon since 1979 (EEC 2000a, 2001a). Since 2000, annual monitoring on the Fort in these three watershed zones and an installation inventory of potential habitat was completed in 1999 with a second inventory scheduled to be completed during the fall survey season in 2002.

As with the San Pedro River, the Huachuca Mountains have a long history of human use. However, it is unclear precisely how those uses affected the habitats of the Huachuca water umbel. Evidence of historic mining activity is commonly encountered throughout the mountain range (Taylor 1991), but mining was more important in the Patagonia Mountains to the west and at Tombstone (Hereford 1993, Hadley and Sheridan 1995). Nevertheless, direct impacts of mining, such as tailings piles, roads, areas cleared for settlements, and probably most important, fuelwood harvest to support the mines and settlers, likely resulted in localized denuded landscapes and degraded watersheds (Hadley and Sheridan 1995.) A sawmill was operated near the mouth of Sawmill Canyon from 1879 to 1882. Other sawmills operated in Carr, Ramsey, Sunnyside, and Miller canyons off-post (Taylor 1991). By 1902, all usable timber had been harvested from the Huachuca Mountains (General Wildlife Services 1999). The Army established a sawmill again at the mouth of Sawmill Canyon in the 1960s, but it operated for only a short period of time and apparently resulted in harvest of very little timber.

Cattle were grazed in the area as early as 1680 (Hadley and Sheridan 1995). Free-ranging cattle were abundant on the Fort in 1886 when the post quartermaster requested fencing of the installation to protect forage for cavalry horses (General Wildlife Services undated). Severe drought combined with overstocking in the 1880s and 1890s led to overgrazing in the region. During the drought, some ranchers drove cattle from the San Rafael Valley into the Huachuca Mountains where forage was cut from oak and ash trees to keep the cattle alive (Hadley and Sheridan 1995). Livestock were not excluded from Fort Huachuca until about 1950 (General Wildlife Services 1999). Currently, the only section of the Fort's boundary that is not fenced is an area just north of Gate No. 7 that is rugged and probably impassable to cattle. Buffalo were maintained on the East Range from about 1947 to 1953. Off-post, the Huachuca Forest Reserve, a precursor to the Coronado National Forest, was established in 1906. Policies were then created to limit grazing to within range capacity and to protect timber resources. These policies were strengthened over time.

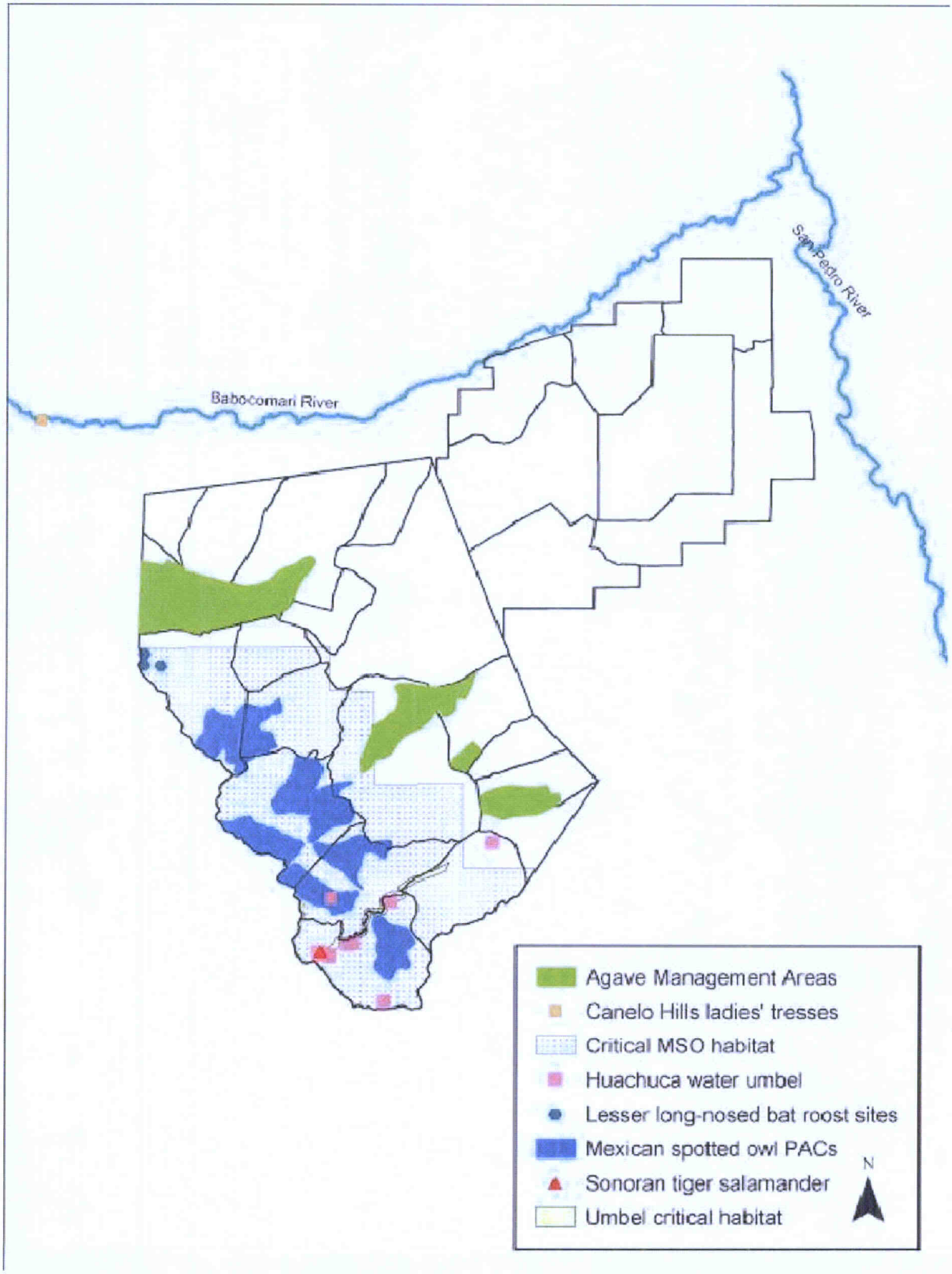

Figure 12. Location of listed and sensitive species on Fort Huachuca, Arizona.

Fire regimes for the Garden Canyon watershed and in a study area around Pat Scott Peak in the Huachuca Mountains were reconstructed using dendrochronological methods (Danzer et al. 1997). Before the establishment of Fort Huachuca in 1877, fires were frequent (mean frequency of 4-8 years), low-intensity (ground fires), and widespread. Since 1870, only two widespread fires have occurred (1899 and 1914) in the study area. Danzer et al. (1997) attribute this change in fire regimes to extensive use of timber, mineral, range, and water resources and associated reductions in fuel loads. Active fire suppression by the Forest Service and others also reduced fire frequency. Exclusion of fire has promoted encroachment of shade-tolerant, less fire resistant tree species such as Douglas-fir, gambel oak, and southwestern white pine, and inhibited growth of pondersosa pine. The 1899 fire was a devastating crown fire that halted all large-scale logging operations at the "Reef" in Carr Canyon and below Ramsey Peak (Danzer et al. 1997.) Danzer et al. (1997) suggest that the fire regime has been altered from frequent, low intensity fire to infrequent, stand-replacing fires. Recent stand-replacing fires on Carr Peak, Miller Peak, and Pat Scott Peak, and the two fires in 2002 support this hypothesis.

Most canyons in the Huachuca Mountains today either are too dry to support Huachuca water umbel, or existing permanent streams exhibit high gradients in narrow, shaded canyons that do not provide the boggy, cienega conditions required by this plant. Whether conditions were different in pre-settlement times is unknown and cannot be reconstructed from available historic accounts. However, erosion due to watersheds degraded by overgrazing, timber harvest, and mining, and erosion and downcutting in streams after stand-replacing fires that began in 1899, may have largely eliminated cienega habitats in the canyons of the Huachuca Mountains. Observations of historic versus current distribution of leopard frogs, *Rana pipiens* complex, suggest wetland habitats in the canyons of the Huachuca Mountains may have been altered in historic times. Leopard frogs, which are primarily frogs of low-gradient streams and boggy pools and ponds, were once found in many canyons in the Huachuca Mountains. The frogs are largely absent today, low-gradient streams and sizeable natural pools and ponds are almost nonexistent, and the only places leopard frogs are found with regularity in the Huachuca Mountains are constructed ponds and livestock tanks.

Effects of the Proposed Action

Possible adverse effects to the Huachuca water umbel could result primarily from three components of the proposed action, including 1) groundwater pumping and subsequent decline of surface flows in the San Pedro River; 2) trampling by military personnel during training exercises or by recreationists, and crushing by vehicles; and 3) scouring or sedimentation and resulting loss of plants and habitat due to degraded watershed conditions resulting from high intensity fire or military training activities.

Effects of Groundwater Pumping

Before discussing the effects of groundwater pumping on the Huachuca water umbel, it is prudent to review the requirements of section 7 in regard to effects analyses, because

groundwater pumping associated with the proposed action may affect the umbel indirectly and possibly not immediately (possibly not within the 10-year life of the proposed action), and interrelated, interdependent, or cumulative effects may be more important than activities carried out, funded, or authorized by Fort Huachuca. Federal regulation 50 CFR 402.14(g)(3) requires the Service to "evaluate the effects of the action and cumulative effects on the listed species or critical habitat. "Effects of the action include "the direct and indirect effec ts of an action on the species or critical habitat, together with the effects of other activities that are interdependent or interrelated with the action, that will be added to the environmental baseline. "Interre lated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). The Service's Section 7 Handbook provides further guidance on the definition of "interrelated and interdependent actions by establishing the following rule: "...the analysis of whether other activities are interrelated to, or interdependent with, the proposed action under consultation should be conducted by applying the "but for test. The biologist should ask whether another activity in question would occur "but for the proposed action. If the answer is no, that the activity in question would not occur but for the proposed action, then the activity is interrelated and interdependent... Cumulative effects are "those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area (50 CFR 402.02).

Regulation 50 CFR 402.14(g)(8) requires the Service to use the "best scientific and commercial data available when formulating a biological opinion, reasonable and prudent alterna tives, and any reasonable and prudent measures. In our analyses, the Service summarizes all reports and information available to us on the hydrology of the San Pedro River basin. Although we believe the reports summarily are consistent about the basic hydrology of the San Pedro subwatershed and the long-term future of the San Pedro River, some disagreement or inconsistencies can be found within these reports. This is due in part to new information that changes our understanding of hydrological relationships, but in some cases authors differ in their interpretations of data sets. We have attempted to base the following analyses and conclusions on the most recent reports, and in order of preference, peer-reviewed published articles, peer-reviewed unpublished reports, non-peer-reviewed unpublished reports, draft reports, and personal communications. Some of the most recent information is in unpublished draft reports that have not been extensively peer-reviewed. Still other information has yet to be written down and is in the form of personal communications. Draft reports and personal communications have been noted as such in the Environmental Baseline. We recognize that the findings in draft reports and personal communications are preliminary and could change upon further review. However, they represent the best information available at this time. If peer review or the publication process alters the findings in these reports or personal communications, or other new information is developed, we will revise this effects analysis and our conclusions as needed.

An early draft of the analysis for the 1999 BO (USFWS 1999a) was peer-reviewed by the Water Resources Division of the U.S. Geological Survey in Tucson (USGS 1998). The USGS found that the "author(s) did an excellent job of reviewing what has been written, both published and unpublished, about the San Pedro River and paraphrasing the findings. However, USGS goes

on to say "Our major comments relate to the conclusions drawn from the information presented. We believe that USGS's primary concern was that the uncertainty over current effects on river flow caused by groundwater pumping in the Fort Huachuca-Sierra Vista area be clearly stated and taken into account in our determination of effects to the water umbel. We revised that analysis accordingly, and most of it is reproduced here, except where new information required us to make changes.

Effects of Unmitigated Groundwater Pumping on River Base Flow

As discussed in the Environmental Baseline, groundwater pumping in the Fort Huachuca-Sierra Vista area has created a large cone or cones of depression in the groundwater aquifer which extends from about the Babocomari River southeast for at least 15 miles. Ground water elevation has declined by as much as 90 feet in this area. If the cone of depression reaches (or if it has already reached) the San Pedro River, it could reverse the flow of ground water, cause gaining reaches to become losing reaches, and result in declines or loss of base-flow (ADWR 1994, Table 9). Before actually reaching the river, base flow is expected to decline due to reduced hydraulic head between the cone of depression and the river. Such declines have probably been occurring for some time (MacNish 1998, San Pedro Expert Study Team 1999), but the magnitude of decline currently attributable to groundwater pumping and the timing of when the river might be significantly affected by the Fort Huachuca/Sierra Vista cone of depression is unclear. Modeling by WESTEC (1996) estimated that agricultural users were responsible for 94 percent of the historic loss of river flow through 1988, while municipal and military users were only responsible for six percent. However, the authors did not calculate current contributions to observed base flow declines. Modeling by ASL (1998) suggests significant effects may occur by 2020 (assuming effluent recharge by Sierra Vista through 2020), while ADWR (1991) believes the river may not be significantly affected for 40 years or more. Although the timing of the effects is uncertain, the modeling efforts and studies reviewed in the Environmental Baseline conclude that flows will continue to diminish or be lost, and in time riparian acreage will be reduced along the upper San Pedro River if groundwater pumping in excess of recharge continues unmitigated.

Effects of Reduced Base Flow on Riverine Habitats and Huachuca Water Umbel

Several changes in riparian and wetland vegetation are expected in response to declining groundwater elevation (Stromberg et al. 1996) and are apparently ongoing in certain reaches of the upper San Pedro River (ADWR 1994). Herbaceous aquatic and semi-aquatic plants found in cienegas or marshes, such as the Huachuca water umbel, are most sensitive to groundwater decline (ADWR 1994). Abundance of obligate wetland herbs declines sharply as groundwater depth drops below about 10 inches beneath the soil surface (Stromberg et al. 1996). Recent changes in riparian and wetland vegetation suggest that groundwater declines are already affecting the habitat of the Huachuca water umbel. Groundwater declines of six feet and three feet have occurred since 1987 on the San Pedro River at Contention (roughly one mile north of the Tombstone gage) and Palominas, respectively. ADWR (1994) notes that "these groundwater declines have been great enough to cause loss of obligate wetland plants and facultative wetland

plants. At Contention, seasonal groundwater flux is about six feet and flows are intermittent. In this area groundwater elevation declined too rapidly to allow survivorship of Fremont cottonwood seedlings (ADWR 1994). During surveys for southwestern willow flycatchers in July 1997, SAIC (1998b) noted that in the reach north of the Charleston Narrows to Boquillas, the river was dry and cottonwoods were beginning to lose their leaves. Riparian trees are typically growing vigorously in July.

Due to its ability to thrive on upper floodplain terraces, prevalence of saltcedar is also predicted to increase under regimes of declining water tables. ADWR (1994) found that saltcedar is increasing on the San Pedro River below Benson and in the downstream end of the SPRNCA, where the river loses water to the floodplain aquifer. At Contention, where groundwater is declining, saltcedar is replacing cottonwoods on young floodplains (ADWR 1994). Loss of trees and possibly a change in tree species composition would cause changes in the habitat of herbaceous species, because canopy cover moderates ambient temperatures, alters light quantity and quality, and may affect channel morphology and dynamics (Menges and Waller 1983, Cross 1991, DeLoach 1991). The causes of apparent recent groundwater declines at Contention and Palominas are not known with certainty, but likely include agricultural and perhaps domestic groundwater pumping (Jackson et al. 1987, ASL 1994, WESTEC 1996, Sharma et al. 1997, MacNish 1998).

In perennial reaches of the San Pedro River, as water levels decline, suitable water umbel habitat would likely move downslope into what is now the active river channel. Huachuca water umbel would likely be more vulnerable to flood events in these sites. With continuing water declines, perennial reaches would go dry seasonally (probably first in May-June). Huachuca water umbel typically occurs in very shallow water or wetted ground, but can withstand seasonal drought and persist in some intermittent reaches, such as in portions of Bear Canyon and Lone Mountain Canyon on the west slope of the Huachuca Mountains. In intermittent stream segments, increasing dry periods would reduce the ability of the plant to grow, reproduce, and expand populations. Even if the water umbel can survive long periods of drought as seeds or rhizomes (Haas and Frye 1997), at some point increasing aridity would eliminate the plant, including seed stock and rhizomes, from intermittent reaches. Other changes associated with declining water tables, described in the preceding paragraph, could result in changes in shading, temperature, and channel dynamics, with varying effects to water umbel habitat. However, by the time water levels declined to a point that riparian woodlands or shrubs were adversely affected, triggering these additional changes, the water umbel would likely already be extirpated due to dewatering.

Huachuca water umbel occurs in six general areas of the SPRNCA. For ease of discussion, the SPRNCA can be divided into four sections. These sections include: 1) the northern most section from Fairbank to the northern boundary of the SPRNCA (Tombstone gauge section); 2) from Charleston northward to Fairbank (Brunchow Hill section); 3) from Highway 90 north to Charleston (Lewis Spring section); and 4) from Hereford north to Highway 90 (near Hereford Bridge section), and one site about 0.5 mile south of the international boundary.

Predicting which area might be affected first by declining groundwater levels is problematic and dependent on the estimated rate of decline and current base flow at specific sites. An examination of current base flow at each locality suggests that populations near Brunchow Hill, about one mile upstream of Charleston, are perhaps the most resistant to water level changes. Base flow at the Charleston Gage is more than three times that at Palominas and less variable than flows at the Tombstone Gage (Vionnet and Maddock 1992, ASL 1995). At Brunchow Hill, if water levels continue to decrease (flows have been declining at this site [ASL 1994]), water umbel habitat would likely move deeper into the river channel as flows declined. Huachuca water umbel would be extirpated from the area if water levels declined enough to dewater water umbel habitat for extended periods of time. Extirpation could also occur if the taxon was restricted to the bottom of the river channel and a large flood scoured the channel. The San Pedro Expert Study Team (1999) noted that although base flow at Charleston is dependably perennial, at times it is only barely perennial (flows as low as 0.05 cfs have occurred in the last ten years - see Table 9 of the report). Thus, although the population at Brunchow Hill may be more resistant to declining base flow than other populations, almost any reduction in flow will result in the river becoming intermittent in the Brunchow Hill-Charleston area.

The southernmost Huachuca water umbel locality in the SPRNCA (from Hereford Bridge north for about one mile) is at the upstream end of the perennial reach where base flows are relatively low. Low flows at Hereford are typically about 40 percent of low flows at Charleston, and periods of no flow have been recorded (Sharma et al. 1997). Increasingly intermittent flows and extirpation of the umbel could result if water levels decline at this site. Based on flow data from the BLM gage at the International Boundary, median flows at the site just south of the international boundary are probably about 2 cfs less than at Charleston, and periods of no flow occur.

Flows near the northernmost water umbel population near the Tombstone Gage are highly variable. ASL (1994) notes that it is not uncommon for there to be no measurable flow at the Tombstone Gage. As a result, this population would probably be extirpated if base flow declined much at all during May to June.

At the Lewis Springs site, where a population occurs in the river, flows are somewhat more than 50 percent of flows at Charleston; periods of no flow have not been recorded (Sharma et al. 1997). Relatively low flows at Highway 90 (about one to two miles south of the Lewis Springs site) and Lewis Springs as compared to flows at Charleston, suggest populations at Lewis Springs and Highway 90 are more vulnerable to groundwater decline than the population at Brunchow Hill (near Charleston). However, the lack of no flow periods at Lewis Springs and Highway 90 suggests populations at these sites may be able to sustain greater declines in flow than populations at Tombstone Gage, Hereford, or the site south of the international boundary, where the river currently goes dry periodically.

Predicted Rate of Groundwater Decline

Predicted rate of groundwater decline is the second factor in assessing risk of population extirpation. USGS (USGS 1998, USFWS 1999a:Appendix 3) believes "the San Pedro River

above Charleston may not be as vulnerable to pumping from (Fort) Huachuca and Sierra Vista as the Babocomari River and the San Pedro River downstream of Charleston. The presence of a clay deposit reinforces this finding and suggests the reach in the vicinity of the Babocomari confluence would be the first area affected by groundwater pumping at Fort Huachuca and Sierra Vista, followed by the reach north of Charleston, and then the reach from Highway 90 to Charleston (Don Pool, pers. comm., 1999). Two water umbel populations occur near the Babocomari confluence (Tombstone gage population). Many populations of water umbel also occur in the perennial reach from Charleston north to the Babocomari, with several more populations occurring in the reach from Highway 90 to Charleston (at Brunchow Hill, Lewis Springs, and populations near Highway 90).

If Sierra Vista's effluent recharge project is successful, flows downstream of the project to at least Fairbank could be bolstered from the year 2000 to 2020 (ASL 1998). The fate of populations just south of the international boundary and at Hereford will probably depend, at least in the short term, on agricultural pumping in these areas and are much less likely to be significantly affected by groundwater pumping at Fort Huachuca or Sierra Vista than downstream populations.

Following from the discussions above, the population at Tombstone Gage (downstream of Fairbank) is probably most at risk in the near future. Populations at Brunchow Hill, Lewis Springs, and Highway 90 are expected to be affected next; the former site may be the most robust of the three in terms of maintaining future base flow. Which of these populations are affected first will depend in part on the location and success of Sierra Vista's effluent recharge project. Flows in the vicinity of the populations near Hereford Bridge and near the international boundary will likely depend on the future of irrigated agriculture near the river both north and south of the border, and will likely not be affected by groundwater pumping at Fort Huachuca and Sierra Vista. Although groundwater elevation at Palominas, located between Hereford and the international boundary, has declined by about three feet since 1987 (ADWR 1994), Sharma et al. (1987) report that the percentage of flow contributed by groundwater discharge has apparently increased at Hereford.

Effects Related to Groundwater Pumping

Appendix F and section 3.7 of the BA present a good analysis, based on best available information, of water use attributable to the Fort's employees (military, civilian, and contractors) and dependents, military retirees, and military survivors. However, this does not reflect the complete effect that Fort Huachuca has on the water use in the subwatershed. The local economy has expanded due to the economic effects of the Fort. For example, some businesses and the employees they support probably would not be in the Sierra Vista area but for the Fort's presence, even though those businesses do not deal directly with Fort Huachuca. Also, some people probably move to the Sierra Vista area due in part to amenities, such as shopping and entertainment, that might not exist in a smaller community without Fort Huachuca. Accurately estimating the number of people in the subwatershed due to this aspect of the Fort's influence on the local economy is difficult, at best. However, the Fort has estimated that this factor adds an

additional 7,093 people that would not live in the subwatershed but for the presence of Fort Huachuca. The additional 500 personnel with family members and the induced economic effect will add another 1,369 people (Appendix I of BA). In summary, effects (direct, indirect, and interrelated/interdependent) attributable to Fort Huachuca include the portion of the current ground water deficit that is proportionate to the population in the Sierra Vista subwatershed that is attributable to Fort Huachuca.

Using the methodology in the 1999 BO with updated population, economic, and hydrological information to determine groundwater pumping attributable to Fort Huachuca gave results that were counterintuitive. Initial figures had the ground water deficit at about 5,500 AF annually, and Fort Huachuca being responsible for about 5,000 AF of ground water use. This would make Fort Huachuca responsible for about 90 percent of the ground water deficit in the subwatershed. Therefore, determining Fort Huachuca employee, contractor, and family member numbers, per capita water use, and the number of people in the watershed attributable to Fort Huachuca's presence, gives a conservation target for Fort Huachuca that is obviously erroneous. This methodology gave such a high proportion because of lower per capita water use for full-time residents on-post, and the Fort receives no credit for off-post water conservation measures which reduce the ground water deficit.

For these reasons, the Fort proposed a different approach. This approach relies less on estimated numbers like per capita water use, so it is much simpler. To determine the impact of Fort Huachuca on the ground water resources in the Sierra Vista subwatershed, they determined the population attributable to the Fort's presence, the total population in the subwatershed, and the ground water deficit in the subwatershed. The proportion of the ground water deficit that is attributable to Fort Huachuca is the proportion of the population in the subwatershed that is attributable to the Fort. This is a simpler and more defensible approach than the one used in the 1999 BO. Based on this approach, Fort Huachuca is responsible for 54 percent of the 5,144 AF deficit in the Sierra Vista subwatershed, or 2,784 AF. We concur that this is an appropriate methodology for assessing water consumption attributable to Fort Huachuca in the subwatershed.

Although continued, unmitigated groundwater pumping in excess of recharge would, in time, result in loss of the Huachuca water umbel from portions of the San Pedro River, pumping is not expected to continue unmitigated. Specific projects to which the Fort is committed include water conservation savings (437 AF), conservation easements (1,600 AF), and storm water recharge (1,040 AF). These projects, totaling 3,077 AF, include various on-post activities, including additional water conservation, watershed improvement, and water recharge projects.

Assuming withdrawals/outflow exceed recharge/inflow in the Sierra Vista subwatershed by roughly 5,144 AF per year (ENRD 2002:Appendix K), implementation of these conservation measures could cut the current deficit by about 60 percent. Implementation of conservation measures, and recharge and watershed improvements currently committed to by the Fort (estimated savings of 3,077 AF per year), will result in net water use by Fort Huachuca in 2011

of roughly 0 AF per year. With implementation of other measures, through the USPP Conservation Plan, additional, but undetermined savings should occur.

In summary, there is uncertainty as to which reach of the river and water umbel sites may be affected first by loss or reduction of flow. However, it is certain that Huachuca water umbel would be negatively affected by declining flows in the San Pedro River. Since the umbel occurs in many sections of the river, diminution of flow anywhere along the river in the Sierra Vista subwatershed would affect Huachuca water umbel sites. The conservation measures proposed by Fort Huachuca, in addition to actions already occurring, mitigate the direct, indirect, and interrelated and interdependent effects of groundwater pumping attributable to Fort Huachuca and should delay any effects to flow in the San Pedro River for decades. Ground water pumping in the subwatershed will not affect any of the water umbel populations that occur on Fort Huachuca.

Effects of Activities at Fort Huachuca Other Than Groundwater Pumping

Activities proposed that have the greatest potential to adversely affect the Huachuca water umbel or its habitat on the Fort include recreational activities, vehicle use, maintenance of roads and firebreaks, water diversions, military testing and training, wildfire ignited by authorized ordnance use or recreation, prescribed fire, and fire suppression. Military training and testing are limited in the canyons where this species occurs, and vehicle use is restricted to existing roads and trails. A hiking trail passes by the population at Sawmill Spring. Limited trampling by recreationists likely occurs at this locality, but is not considered a serious threat to this population. The population at Middle Garden Canyon picnic ground is located in the picnic area and likely subject to trampling, but the Fort has placed large boulders around the area to prevent vehicles from driving through the habitat. Other populations in Garden and McClure Canyons receive less use by recreationists, and trampling and damage by vehicles are less likely to occur in these areas.

A pipeline is present which can divert part of the flow in Garden Canyon for downstream use. The potential amount is unknown, but the source is eight springs, with the uppermost spring located near the pictograph sites. From this point, water is collected and diverted in a pipeline from the various springs along Garden Canyon Creek (Tom Cochran, pers. comm., 1998). The Fort has removed all uses from this pipeline. Diversion during 1900 to 1940 may have been responsible for reduced establishment and vigor of sycamores during that period (General Wildlife Services 1999). The pipeline infrastructure will remain intact and may be used in the future for mobilizing, emergencies, and fire fighting. These uses are expected to be infrequent and of short duration, and thus should minimally affect water umbel in Garden Canyon.

Although not directly affected by activities at Fort Huachuca, the Huachuca water umbel population in Scotia Canyon has likely been affected by recreationists that used the road through Gate No. 7 into Scotia Canyon. Sections of this road are highly eroded and braided between Gate No. 7 and the lower Peterson Ranch Pond. Erosion and sedimentation resulting from use of the road may be affecting Huachuca water umbel populations downstream of the eroded areas.

Increased runoff and erosion may result in scouring of the stream channel or burial of plants due to sedimentation. Of particular concern is a head cut just below the lower Peterson Ranch tank. Huachuca water umbel is abundant at the tank and in the reach immediately downstream of the tank. If the head cut moves upstream another 20 to 40 feet, the tank will be breached resulting in serious erosion and scouring. Use of the road by recreationists could increase the chances that the tank will wash out. Fort Huachuca has closed Gate No. 7 and it will remain closed.

Erosion on other roads or firebreaks in the watershed of the water umbel is unknown, but is also potentially a threat. The road through Garden Canyon is well-maintained and little erosion appears to be associated with its use and maintenance. However, portions of the road are subject to periodic wash-outs and associated downstream impacts during severe storm events.

Fire and subsequent runoff and erosion of canyon bottoms are the greatest threats to Huachuca water umbel populations on-post in the Huachuca Mountains. Degradation of watershed condition immediately after fires can result in dramatically increased runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). In degraded watersheds, less precipitation is captured and stored, thus perennial aquatic systems downstream may become ephemeral during dry seasons or drought (Rinne and Neary 1996). These conditions could result in decline or extirpation of Huachuca water umbel populations in Garden and McClure Canyons, or at Sawmill Spring on the Fort or in adjacent off-post canyons that might be affected by fire on Fort Huachuca (i.e., Scotia and Bear Canyon populations). Fires could be intentionally ignited (prescribed fire or arson) or ignition could result from lightning strikes or unintended human ignition such as campfires, cigarettes, or ordnance. Fires associated with campfires or cigarettes are most likely to occur along roadways or at campgrounds and picnic sites. Live fire ranges and firing fans are shown in Figure 6 of the BA. All Huachuca water umbel populations on Fort Huachuca are close enough to currently-used firing fans that a fire ignited by ordnance could potentially reach the site and adversely affect habitat. Even non-explosive ordnance could result in fire if it landed or skipped on rocks, causing sparks.

Robinett et al. (1997) assembled a fire history for 1973 to 1993 (Figure 13). Fires have been few or absent from the higher elevation Huachuca water umbel populations (McClure and upper Garden Canyons, and Sawmill Spring). Several fires burned near the Middle Garden Canyon population and at or near the lower Garden Canyon populations. Although fires at high elevations have been infrequent, recent high intensity crown fires to the south of Fort Huachuca (Carr Peak Fire in 1977, Pat Scott Peak Fire in 1983, and the fires in 2002), combined with high fuel loads in some of these areas (Danzer 1997), suggest that a stand-replacing fire could potentially occur at Fort Huachuca during the life of the project.

General Wildlife Services (1999) suggest that Garden Canyon "is perhaps primed for a catastrophic fire that could lead to major erosion and debris flow on the mid-elevations of the watershed and possible flooding and channel scouring in the lower drainage. They note that there have been no recent fires on the Garden Canyon watershed, fuels are relatively dense, the

watershed probably has a deep "regolith available for debris flow, and the watershed is large enough to collect a sizeable runoff from a major storm event.

The Fort has committed to initiating prescribed fires and fuels management in the Huachuca Mountains, in addition to other fire-related conservation measures. A Fire Management Plan has been drafted (Robinett et al. 1997) that provides a planning framework for reducing the risk of catastrophic stand-replacing fires. Over time, plan implementation should significantly reduce the threats to water umbel habitat due to possible erosion, scouring, and sedimentation following a severe wildfire. The risk of a stand-replacing fire that burns over a large area is also reduced due to a network of fire breaks that the Fort maintains along ridges.

Wildfires occurred infrequently on the East Range from 1973 to 2002 (Figure 13). Conceptually, a fire could start on the East Range and spread to the San Pedro River, which is about 0.6 miles away from the East Range boundary at its closest point. Fire could destroy riparian vegetation, change the microclimate of water umbel sites, and cause increased runoff, erosion, and sedimentation that could eliminate water umbel populations. However, fires are typically small, the Chihuahuan desert scrub on the East Range provides little fuel to carry fire, and fire breaks and roads help prevent fires from spreading very far. Fire breaks surround Zulu, which is a live fire impact zone, and another fire break is located on the east boundary of the East Range. Only one, small fire occurred on the eastern half of the East Range during 1973 to 2002; and fires ignited on the East Range have never burned into the San Pedro RNCA (J. Hessil, pers. comm., 1998). The Service believes that the threat of fire spreading from the East Range to the San Pedro River is insignificant. Also, conceivably, a live shell could miss Zulu, land in the SPRNCA, and start a fire. However, this has not happened to date and is considered extremely unlikely.

Although active fire suppression is critical to reduce damage from wildfire, suppression activities can adversely affect the water umbel. Decisions made during fire suppression can affect the degree and intensity of fire effects, and the type and location of suppression activities could directly or indirectly affect water umbel habitat. Use of heavy equipment, such as tracked vehicles, to cut fire lines or reduce fuels could destroy habitat, cause erosion, or create new routes of travel that may lead to increased access and recreational impacts. However, the Fort has committed to making protection of water umbel habitat an objective of fire suppression, off-road vehicle activity, including tracked vehicles, would be minimized, a resource advisor would be on-site during all fires to advise the fire boss of species issues, and areas disturbed would be kept to a minimum and located outside of areas important for the water umbel whenever possible, and rehabilitated.

Watersheds can be degraded by a variety of activities other than fire. The East Range, which encompasses about 28,544 acres, lies in the watersheds of the Babocomari and San Pedro Rivers. The vegetation and soils of the East Range consist of highly impacted areas intermingled with large tracts of relatively undisturbed habitat. Disturbance has resulted from overgrazing and agricultural development, which predates military use, and military activities such as existing

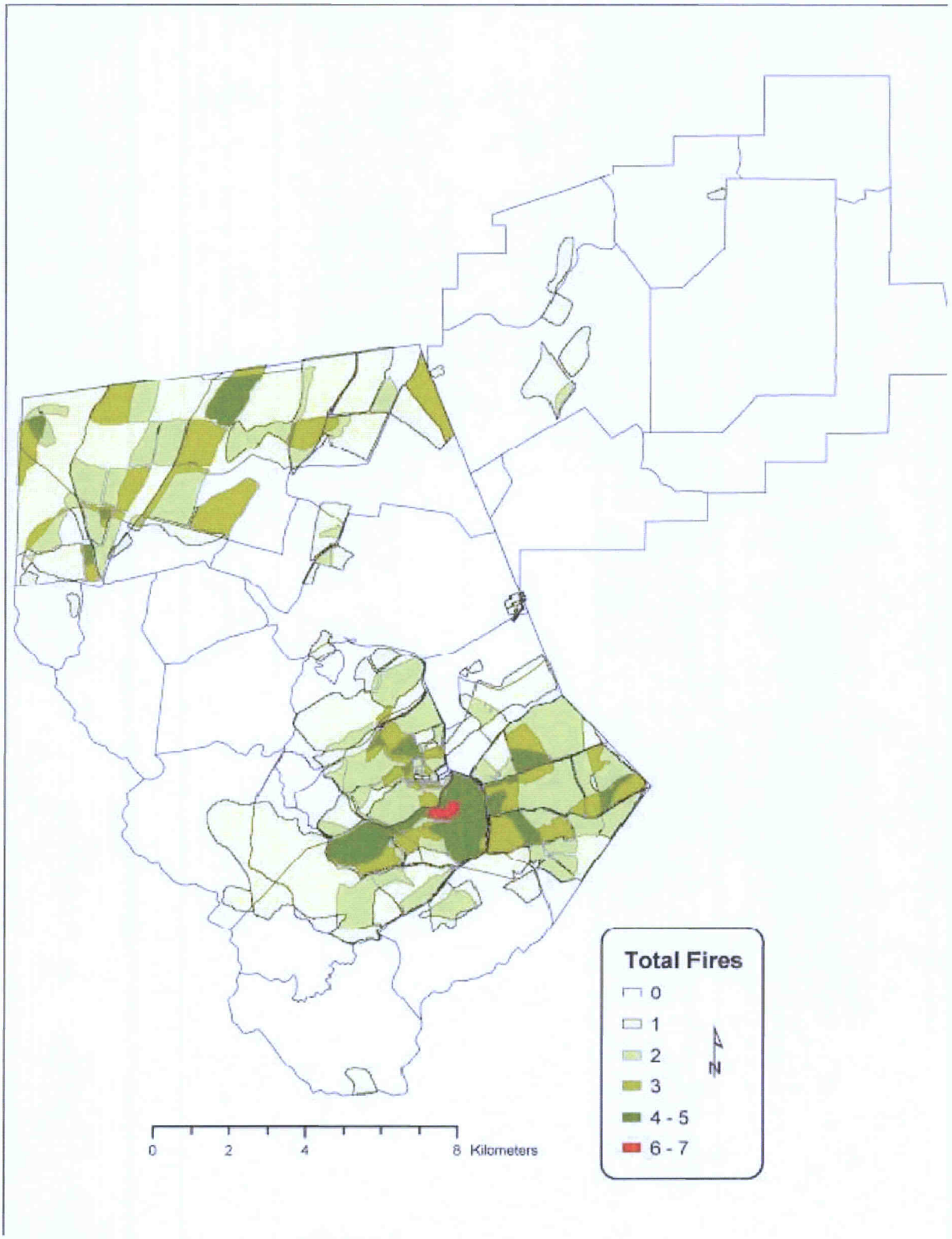

Figure 13. Fort Huachuca, Arizona, fire frequency from 1973 to 2002.

routes, a landing strip, and five off-road maneuvering areas not planned for use (ENRD 1997). Watershed condition is degraded in a band, about two to three miles in width, that runs across the East Range from the northwest to the southeast.

Brush encroachment and relatively steep slopes results in erosion and downstream sedimentation. Sheet, rill, and gully erosion occur extensively in this area (ENRD 1997). Along the eastern boundary of the East Range is an area of soil deposition. Soils eroded off the watershed to the west are being deposited here and later washed away toward the San Pedro River during gully headcutting. Brush is encroaching in this area as well. In other areas of the East Range, the nonindigenous Lehmann lovegrass (*Eragrostis lehmanniana*) is invading. Watershed condition is improving in these areas due to the ability of Lehmann lovegrass to slow runoff and soil erosion (ENRD 1997).

The watershed condition of the east Range is degraded (ENRD 1997). Degraded watersheds can cause increased surface runoff and sediment transport, and decreased infiltration of precipitation (Gifford and Hawkins 1979, DeBano and Schmidt 1989, Belsky and Blumenthal 1997). Potentially, degraded watershed conditions on the East Range could result in higher peak flows, lower low flows, and sedimentation or erosion of the San Pedro and Babocomari rivers. Such conditions could result in increased likelihood that the Huachuca water umbel population near Fairbank, which is downstream of the East Range, could be scoured during peak flows or buried by sediment. However, studies by the Environment and Natural Resources Division at Fort Huachuca (1997) indicate that most sediment eroded from the East Range is deposited along the Fort's eastern boundary and does not reach the San Pedro or Babocomari rivers. The lower-elevation portions of San Pedro River watershed are much degraded due to development, a long history of livestock grazing, and conversion of grasslands to shrublands. The effects of watershed degradation on the East Range are probably largely masked by watershed problems elsewhere along the San Pedro River. Fort Huachuca has proposed a number of erosion conservation measures to reduce the effect of erosion on umbel populations and critical habitat. These include no off road vehicle travel on the installation and implementation of the East Range Watershed Improvement Plan which includes activities such as revegetation, installation of structures to slow erosion and trap sediment, placement of waterbars along roads, and closure of unneeded roads.

In summary, military training, fire, and recreation may similarly impact Huachuca water umbel through increased erosion, sedimentation, and changes to flow regimes. The conservation measures proposed by Fort Huachuca will minimize the potential for these effects to occur to Huachuca water populations on the Fort and along the San Pedro River.

Other Off-Post Activities

The presence of Fort Huachuca employees, contractors, dependents, and others in the Sierra Vista subwatershed has other effects on the water umbel and its habitat. Agricultural and urban development may result in watershed degradation and subsequent adverse effects to biotic

integrity and habitat quality in adjacent riparian systems (Wang et al. 1997). In Wisconsin, urbanization rates of between 10 and 20 percent in watersheds consistently resulted in low indices of biotic integrity (Wang et al. 1997). Urbanization results in increased runoff, and resulting changes in flow regimes, water temperature, and channel morphology (Wang et al. 1997, Schueler 1994). Runoff from urban areas also reduces water quality by carrying toxicants and high nutrient loads (Wang et al. 1997).

The increased human population in the subwatershed as a result of Fort Huachuca probably also results in increased recreational use of Huachuca water umbel sites, both on- and off-Post. Increased recreational use results in greater chance of fire, trampling, and off-road vehicle damage, all of which can adversely affect water umbel populations.

Effects to Critical Habitat

Critical habitat for the Huachuca water umbel was designated in 1999, in the project area on 3.8 miles of upper Garden Canyon on Fort Huachuca, and 33.7 miles of the upper San Pedro River from about 600 feet south of Hereford Bridge to just north of Fairbank. Critical habitat was also designated in nearby Scotia Canyon, just west of Gate No. 7 of Fort Huachuca, and in other canyons on the west slope of the Huachuca Mountains. Effects analyses must determine if the proposed action would destroy or adversely modify critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical (50 CFR 402.02). The primary constituent elements identified in the final rule as necessary for the survival and recovery of the Huachuca water umbel include, but are not limited to, the habitat components which provide the following:

> Sufficient perennial base flows to provide a permanently or nearly permanently wetted substrate for growth and reproduction of Huachuca water umbel;
>
> A stream channel that is relatively stable, but subject to periodic flooding that provides for rejuvenation of the riparian plant community and produces open microsites for water umbel expansion;
>
> A riparian plant community that is relatively stable over time and in which nonindigenous species do not exist or are at a density that has little or no adverse effect on resources available for water umbel growth and reproduction; and
>
> In streams and rivers, refugia sites in each watershed and in each reach, including but not limited to springs or backwaters of mainstem rivers, that allow each population to survive catastrophic floods and recolonize larger areas.

As discussed in the "Effects of Groundwater Pumping and "Interrelated and Interdependent Effects , without a concerted effort to balance the water budget or otherwise mitigate the impacts of groundwater pumping, dewatering and loss of riparian vegetation could result on portions of the 33.7 miles of critical habitat on the San Pedro River. Critical habitat north of Charleston, particularly near the Babocomari confluence, (15.3 miles) is most at risk, followed by the reach from Highway 90 to Charleston (5.5 miles). The City of Sierra Vista's effluent recharge project is expected to delay these effects if the project is successful (ASL 1998), but in the long term, base flows and the constituent elements of water umbel critical habitat are threatened by groundwater overdraft. Evidence suggests that dewatering is already occurring, although the cause is unclear and may or may not currently be attributable to effects of the action (ADWR 1994, ASL 1994, WESTEC 1996, Sharma et al. 1997, Fenske 1998, Koehler and Ball 1998, Pool et al. 1998, MacNish 1998, SAIC 1998b, San Pedro Expert Study Team 1999). Cumulative effects are as described above for the species. These effects exacerbate the effects of the action. Of particular concern is the potential for agricultural development near the river, which could result in dewatering the only portion of critical habitat on the San Pedro River that may not be affected by the project (Hereford to Highway 90).

Because the upper San Pedro River is the only large, contiguous habitat of the water umbel, it is the most important of the critical habitat areas to the survival and recovery of the species. Loss of this habitat would appreciably diminish the value of critical habitat for both the survival and recovery of the Huachuca water umbel. In the final critical habitat rule, the Service found that activities such as excess groundwater pumping that appreciably decreases base flow and appreciably reduces the wetted surface area of perennial rivers or springs may destroy or adversely modify critical habitat.

Unless a concerted effort is made to manage water resources in the subwatershed, groundwater use will continue to exceed supply, resulting in at least decades from now a loss of Huachuca water umbel critical habitat on the upper San Pedro River. The Fort's proposed conservation measures and the Upper San Pedro Partnership's regional planning process provide a framework for such an effort. It finally appears that the ground water deficit in the subwatershed is no longer growing. In 1990 the estimated deficit was 7,000 AF; in 2002 the estimated deficit is 5,141 AF; and a worst case scenario for 2011(with only Fort Huachuca's commitments) is 3,306 AF). Fort Huachuca has committed to contributing considerable leadership, technical support, funding, and other resources to hasten the success of these efforts. Successful implementation of the Sierra Vista and Fort Huachuca effluent recharge projects, along with the Fort's conservation measures, should provide the time necessary to develop and implement plans before significant effects occur to river base flow and greatly lengthen the time until impacts to base flow in the San Pedro River may occur.

Activities at Fort Huachuca other than groundwater pumping also have a potential to adversely affect critical habitat. These activities include recreational activities, vehicle use and maintenance of roads and firebreaks, water diversions, wildfire ignited by authorized ordnance use or recreation, prescribed fire, and fire suppression. The most important of these are wildfire

and prescribed fire, and fire suppression activities. Wildfire ignited by recreationists or ordnance, prescribed fire, and fire suppression activities could result in direct effects to water umbel critical habitat in Garden Canyon, or perhaps in nearby Scotia Canyon. Indirect effects could also occur from these activities, particularly as a result of watershed degradation and subsequent erosion, sedimentation, and changes in stream hydrology. The Fort has proposed a number of measures to reduce the chance of catastrophic fire in the Huachuca Mountains and to minimize adverse effects to critical habitat due to fire suppression activities. Conservation measures are adequate to remove most threats to Huachuca water umbel populations on the Fort. Conservation measures would improve degraded watershed conditions on the East Range and address fire, groundwater use, and human disturbance threats to the species and its critical habitat.

Effectiveness of Proposed Conservation Measures

The purpose of this section is to address the conservation measures Fort Huachuca proposes to implement by 2011. As detailed in the proposed action and Section 5 of the BA, Fort Huachuca proposes to implement conservation measures totaling 3,077 AF which will completely offset all direct, indirect, interrelated and interdependent effects associated with its proposed action by the year 2011. The proposed 3,077 AF will offset 60 percent of the current total estimated deficit in the subwatershed (5,144 AF). In addition, Fort Huachuca will offset all increased water pumpage associated with potential personnel/mission increases in the future, i.e., up to 500 personnel. By reducing 3,077 AF in groundwater usage, in 2011 there will be no effect on the Huachuca Water Umbel or its critical habitat associated with Fort Huachuca's groundwater usage.

1. Fort Huachuca will conduct an inventory of all potential umbel habitat on the installation every three years with frequency transects conducted at documented umbel populations in the other two years.

2. On the SPRNCA, Fort Huachuca will conduct an inventory of all potential umbel habitats every three years. No frequency transects are required. All inventory and monitoring activities will be done from September 15 through October 31 of each year.

3. The Fort will maintain rock barriers around Huachuca water umbel populations.

4. The Fort will begin prescribed fire and fuel management in the Huachuca Mountains.

5. The Fort will maintain the barrier to vehicle travel at Gate No. 7.

6. General fire coordination will be accomplished as specified in Section 5.4.7 of the BA.

7. The Fort will fund water umbel habitat management or restoration where habitat has been degraded or lost, or where potential exists for creating water umbel habitat. Assistance will take the form of funding or technical assistance. Projects funded should include both off-post and on-post projects. On-post activities could include restoration and protection of cienega conditions in Garden Canyon and other wet sites. Off-post, the Fort could assist BLM, the Coronado National Forest, or other land owners and managers of water umbel habitat potentially affected by the proposed action. Off-post projects that the Fort should consider funding include cienega restoration or protection in Scotia Canyon or elsewhere in the Huachuca Mountains, if approved by and coordinated with the Coronado National Forest, and restoration or protection of cienega conditions on the San Pedro RNCA, if approved by and coordinated with the BLM. All plans and agreements for funded projects should be coordinated with and approved by the Service.

8. The Fort will monitor and document any disturbance of umbel or habitat. This and other monitoring required here will be reported to the Service following the reporting requirements described in the BA.

9. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance most direct, indirect, interdependent and interrelated effects.

10. Fort Huachuca will complete a Huachuca water umbel Endangered Species Management Plan in 2003.

11. All maintenance activities in Garden Canyon will occur within the existing roadbed or catch basins and will only occur during the day. Silt fencing will be used where there is the potential for sediment to enter Garden Canyon Creek. No vegetation will be removed outside of the existing roadbed and no invasive plant or animal species will be introduced. No water will be used from Garden Canyon Creek. Contractors will be trained to recognize Huachuca water umbel and instructed to follow these conservation measures.

The conservation measures are adequate to remove the most serious threats to Huachuca water umbel. Measures recommended by Fort Huachuca (ENRD 1997) are also adequate to improve degraded watershed conditions on the East Range and thus reduce watershed-related threats to the water umbel population and critical habitat near the Tombstone gage on the San Pedro River. These measures would have to be implemented promptly and successfully to avoid adverse effects to Huachuca water umbel and its critical habitat.

We commend the Fort for implementation of many water conservation practices that have reduced water use in recent years (SAIC 1998a, ENRD 2002). Such practices serve as models for other water users in the subwatershed. If currently proposed and continuing water management projects are implemented, water savings, easements, and recharge of at least 3,077

AF per year could result, reducing the net effect of the Fort on ground water to zero. The City and Fort's effluent recharge projects, if operated as expected, may insulate a significant reach of the river from the effects of groundwater pumping for at least 20 years. The Fort's conservation measures should increase the length of time that the river may be unaffected from ground water use in the subwatershed. Additional measures are needed by the entities in the USPP to address the groundwater deficit not attributable to Fort Huachuca.

Fort Huachuca recognizes that despite its conservation measures resulting in a net reduction of 3,077 AF, this will not completely eliminate the groundwater deficit in the Sierra Vista subwatershed. Indeed, by subtracting 3,077 AF from the total groundwater deficit of 5,144 AF, the part of the groundwater deficit not attributable to Fort Huachuca is 2,067 AF. Moreover, the projected population increase of 12,931 people would result in a net increase of 1,239 AF of additional groundwater use in the Sierra Vista subwatershed by 2011. By taking the existing groundwater deficit of 2,067 AF and adding 1,239 AF of projected additional water usage, the total groundwater deficit by 2011 not attributable to Fort Huachuca will be about 3,306 AF.

The ground water deficit is likely to be less than what it is now, but that only delays when the loss of base flow in the river may occur. The population near the Tombstone gage would likely be affected first by groundwater pumping at Fort Huachuca and Sierra Vista, but populations at Brunchow Hill, Lewis Springs, and near Highway 90 could also be threatened by groundwater pumping. Even if enough conservation measures are implemented so water supply equals or exceeds water use, the cone of depression is expected to continue its lateral expansion as it flattens out and could dewater portions of the San Pedro River (see scenario 1 of WESTEC 1994, Table 9), unless effluent recharge is successful in ameliorating effects to the river, or other measures, such as water importation or pumping water into the river are employed to maintain river flow.

As discussed above, despite these efforts by the Fort, implementation of these conservation measures, as well as measures presently implemented by the City of Sierra Vista, would, even under optimistic conditions, still result in water use from the aquifer in excess of water supply and result in continuing growth in the already very large cone of depression under Fort Huachuca and Sierra Vista. The Fort has committed to promoting and leading the USPP's efforts to maintain base flow in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act. The first working draft of the USPP conservation plan is scheduled to be completed in 2003. A variety of other teams and partnerships, such as the San Pedro Expert Study Team, Advisory Panel on the Upper San Pedro Initiative, recommendations of the Water Issues Group, as well as designation of the San Pedro RNCA and negotiations on the ongoing Gila River adjudication all have provided direction, ideas, and incentive to protect the riparian resources of the upper San Pedro River. Taken together, they provide a framework for Fort Huachuca to work with other agencies, Cochise County, the City of Sierra Vista, and others to protect water umbel populations and critical habitat.

In summary, we believe that the Fort's implementation of the proposed conservation measures should minimize and alleviate impacts to Huachuca water populations on the Fort and along the San Pedro River as a result of their proposed action. The Fort will continue to work with the USPP to assist with minimizing groundwater consumption in the subwatershed that is not attributable to Fort Huachuca's presence.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, or local private actions that are reasonably certain to occur in the project area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation following section 7 of the Act. Effects of past Federal and private actions are considered in the Environmental Baseline.

Groundwater Pumping

Due to Fort Huachuca's ongoing water conservation efforts (reduced water consumption by over 1,000 AF since 1993) and the City's effluent recharge project, the water deficit in the Sierra Vista subwatershed is 5,144 AF, instead of the generally used number of 7,000 AF. By subtracting Fort Huachuca's conservation measures of 3,077 AF, the current groundwater deficit not attributable to Fort Huachuca, is 2,067 AF which is considered part of the environmental baseline.

This figure of 2,067 AF does not include projected population growth. The best available data on project population growth and its associated water use is the 2000 Census data. There are about 64,655 people who live in the Sierra Vista subwatershed. The Sierra Vista subwatershed includes the Sierra Vista, Tombstone, Huachuca City, Bisbee, Naco, Whetstone, and unincorporated areas southeast of Sierra Vista. Some of these municipalities have not grown or have grown very little the past 10 years. Sierra Vista increased its population, but it was much slower than anticipated. From 1990 to 2000, the City of Sierra Vista increased its population by 14.5 percent (37,775) while Cochise County increased by 20.4 percent (117,755). Overall, the growth rate was about 2 percent per year. Using Fluid Solutions USPP Report (July 2001), the annual forecast for future population growth is 2 percent for Sierra Vista, 0.4 percent for Tombstone, 0.5 percent for Bisbee, 1.5 percent for Huachuca City, and 1.3 percent for unincorporated areas. Using an average of 2 percent would equate to a total of about 77,586 people in the in the Sierra Vista subwatershed by 2010. Of the about 13,000 additional people, 6,500 people would be living in the City of Sierra Vista and 6,500 would be outside Sierra Vista. The projected population increase would result in a net increase of 1,239 AF of additional groundwater use in the subwatershed by 2011. This includes the correction for the associated recharge going back into the aquifer from either effluent recharge facilities or septic systems. By taking the existing groundwater deficit not attributable to Fort Huachuca of 2,067 AF and adding 1,239 AF of projected additional water usage, the total cumulative groundwater deficit by 2011 will be about 3,306 AF. The 1,239 AF of additional groundwater use are cumulative to the

proposed action and represents the best estimate of use likely to occur within the 10-year time frame of the proposed action.

Regional water resource planning is needed to address the deficit in the water budget and the associated threat to river base flow. Fort Huachuca has an Army Water Resources Management Plan and participates in the Upper San Pedro Partnership conservation planning effort. It is anticipated that these efforts, combined with the bilateral international agreement between the United States and Mexico on protecting the San Pedro River, will provide the framework for long-term planning and actions that will reverse current trends and provide for maintenance of river base flow and habitats of the Huachuca water umbel on the San Pedro River. Although uncertainties exist, the hydrology of the basin is relatively well understood, and several sets of recommendations on how to reduce consumptive water use or increase recharge have been developed. The Service expects that the USPP conservation plan will be drafted in 2003. Projects are already being planned and tested. The Fort has committed to provide considerable leadership, technical support, funding, and other resources to facilitate development and implementation of a plan. Other participants also must provide leadership and resources to develop and implement a plan that will protect river base flow in the long term. Success of the Sierra Vista and Fort Huachuca effluent recharge projects is critical as a means to have time to develop and implement a regional conservation plan before significant effects occur to water umbel habitat.

Fort Huachuca proposes to request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 (3,306 AF). Bisbee is currently planning to begin construction of an effluent recharge facility in two years. When constructed in five years the effluent recharge plant is projected to recharge about 392 AF.

The potential effects of groundwater pumping on the San Pedro River ecosystem have been known for some time, and as just discussed, many projects, regulatory mechanisms, and initiatives have been suggested to protect the river. Significant collaborative efforts have recently been initiated to plan for, fund, and implement some of these measures. It is valuable to review these efforts because the committees, agencies, and others behind these efforts are beginning to make significant progress in addressing the region's groundwater deficit.

The Upper San Pedro Partnership has identified a number of strategies that could be pursued, including requesting that ADWR establish an irrigation non-expansion area in the subwatershed, acquisition of ephemeral arroyos to maximize aquifer recharge, elimination of groundwater pumping within one mile of the river through exchange of state lands or acquisition of private lands or water rights near the river, assistance to communities in securing funding for feasibility studies to determine the best use of their effluent, increased recharge of storm water runoff, investigation of moving Bisbee's wells to outside of the San Pedro watershed, and other measures. The Partnership is doing longer-term water resources planning to develop other strategies.

On June 22, 1999, Interior Secretary Bruce Babbitt and Mexican Ambassador Jesus Reyes-Heroles signed a joint declaration to improve and conserve the natural and cultural resources of the upper San Pedro River basin, including the river and riparian corridor. The declaration creates a partnership to share funds, information, and conservation expertise between land and resource managers in both countries. Planned activities include reprogramming of Land and Water Conservation Funds for purchase from willing sellers of fee titles and conservation easements near Palominas, which should help protect the river from agricultural pumping.

On a state level, the Growing Smarter Plus legislation was signed in 2001 which provides a methodology for setting aside state trust lands adjacent to rural cities as open space, creating conservation easements, and purchasing development rights easements, to name a few. However, the water element of this legislation requires communities and counties with populations over 125,000 people to have a water resource section in growth plans. While the regional population according to the 2000 Cochise County census did not cross this threshold, the Cochise County Board of Supervisors has developed a baseline of existing water resources to help assess water use in its County growth plans (EEC 2002).

The ADWR is active in the rural watershed initiative and is engaged in a monitoring program to determine water level changes in the region. The University of Arizona Agriculture Extension Service has been involved in the Water Wise Program encouraging more school education, water audits, and other water conservation activities.

As mentioned above, a baseline of countywide water resources has been completed for Cochise County. Cochise County is involved in a mountain front recharge instrumentation program with Sierra Vista to quantify the recharge volumes from basins along Buffalo Soldier Trail. Since 1992 the County has actively monitored and participated in the Technical Review Committee to discuss and improve the science and state of hydrology in the region. Cooperative cost sharing is provided for USGS flow gauges at Charleston/Palominas/Babocomari. Fort Huachuca has provided funding for these gauges, and others. The County has provided classes at Cochise College on San Pedro water issues, studying urbanization effects on ephemeral stream channel geometry, and participating in an ephemeral stream recharge study with the Agricultural Research Service to quantify the recharge volumes from the ephemeral stream on the Walnut Gulch experimental watershed.

The City of Sierra Vista has implemented the Sierra Vista Watershed Protection Program to provide for the sustainable future of the Sierra Vista community while protecting the unique habitat of the San Pedro Riparian National Conservation Area. Protecting this habitat is the primary focus of the Sierra Vista Watershed Protection Program. A San Pedro River informational booklet and video, formation of an environmental affairs commission, establishment of a successful Water Wise Program, and creation of a school programming initiative have also been generated locally. A surface water plan is in development that will establish a series of storm water detention and retention basins throughout Sierra Vista that would help alleviate flooding and increase recharge opportunities. The City is also participating in a cooperative recharge project with Cochise County and Fort Huachuca. Low-flow fixtures

and on-site retention/recharge ordinances have improved the local development code by mandating low water flow fixtures in all new construction and retention of surface flows to pre-construction conditions. The City recently obtained voter approval to own and operate two local water companies, which gives the City the authority to implement further conservation and recharge measures.

The San Pedro Alliance, a non-governmental entity, was created with the objective of providing information and plans for reducing water usage and sustaining the river in the long term. The Nature Conservancy has been active in local forums, and in public education and acquisitions of land and easements. The Udall Center for Studies in Public Policy has also been working in the subwatershed to inspire and enable community members to contribute to water-wise planning and management activities in the upper San Pedro River basin.

Although employment and effective population at Fort Huachuca are expected to increase by 500 jobs over the next 10 years (ENRD 2002), the population of the Sierra Vista subwatershed is expected to increase from the 1990 estimate of 51,400 to 73,900 in 2030, with a resulting increase in consumptive water use of about 5,300 AF per year over use (San Pedro Expert Study Team 1999). Because the Fort is only expected to increase by 500 jobs over the next 10 years, this increase cannot be directly attributed to the Fort; although it is not possible to predict how growth in the subwatershed might be affected if the Fort was not present. Nevertheless, it is clear that growth in the area has achieved momentum that is separate from any influence Fort Huachuca might have. The projected growth in water consumption in the subwatershed and the resulting continued deficit between recharge and use poses the greatest threat to the water umbel and its habitat on the San Pedro River.

Of great concern is the potential for additional agricultural development and associated pumping of groundwater in the floodplain of the San Pedro River in either the U.S. or Mexico. Extensive acreage in Mexico and on private and state land in the U.S. could potentially be developed for agriculture (San Pedro Expert Study Team 1999). This may become less of a threat if initiatives to designate irrigable lands as irrigation non-expansion areas or if purchase of lands or easements from willing sellers are implemented. As discussed in the 'Environmental Baseline a number of initiatives and planning processes are underway at local, state, Federal, and international levels that are expected to reduce cumulative effects due to groundwater pumping in the upper San Pedro River basin.

In summary, cumulative effects to groundwater (1,239 AF) are expected to occur over the next 10 years (and beyond), primarily from an increasing population in the subwatershed. Additional water use in Mexico could also use additional groundwater, though the effects of water use in the Mexican portion of the upper San Pedro basin are poorly understood. The efforts of the Upper San Pedro Partnership are expected to contribute greatly to reducing not only the cumulative groundwater use, but also 2,067 AF of the current groundwater deficit that is not attributable to Fort Huachuca.

Other Activities

Many other activities that may impact the Huachuca water umbel in the area would be considered a Federal action, and thus are not considered cumulative effects. Exceptions may include activities on private lands in Scotia, and Bear Canyons on the west slope of the Huachuca Mountains, and at other sites in the San Rafael Valley. The most likely impacts in these areas would be livestock grazing. The water umbel is apparently able to coexist with well-managed livestock grazing; however, historic and long-term effects of grazing on riparian systems supporting the water umbel have been detrimental. Effects of livestock grazing on the water umbel on lands managed by the Coronado National Forest were recently addressed in a formal section 7 consultation. Private lands in Scotia Canyon may be acquired by the Coronado National Forest through a land exchange.

Conclusion

After reviewing the current status of the Huachuca water umbel, the environmental baseline for the action area, the effects of the Fort's activities, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Huachuca water umbel and is not likely to result in adverse modification and destruction of critical habitat. We present these conclusions for the following reasons:

1. The Fort has proposed or is implementing conservation measures to significantly reduce or eliminate effects of the proposed action to populations of water umbel and its critical habitat.

2. The Fort has committed to implementing conservation measures (3,077 AF), included in the Army Water Resources Management Plan, that will not only bring Fort Huachuca's use of groundwater resources in balance with recharge, it exceeds the portion of the groundwater deficit that is attributable to them (2,784 AF). The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats.

3. The Bureau of Reclamation and City of Sierra Vista have developed an effluent recharge project that is expected to delay effects to river base flow and water umbel habitats on the San Pedro River by addressing baseline and cumulative effects not directly attributable to Fort Huachuca. Although this project does not alleviate the long-term threat to water umbel habitats on the San Pedro River, it is expected to provide time to develop and implement plans to address those long-term threats before further impacts to the umbel or its critical habitat occur.

Note that in regard to "take of listed species in sections 7(b)(4) and 7(o)(2) of the Act, these sections generally do not apply to listed plant species, thus no incidental take statement is included here for the Huachuca water umbel. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed endangered plants and malicious damage of such plants on areas under Federal

jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of state law or regulation or in the course of any violation of a state criminal trespass law.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendation provided here does not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the Huachuca water umbel. In furtherance of the purposes of the Act, we recommend consideration of the following actions:

1. The Fort could provide assistance to the Service in developing a recovery plan for the Huachuca water umbel. In addition, the Fort should develop and implement with the BLM and the Coronado National Forest a regional conservation plan for managing the Huachuca water umbel in the San Pedro River/Huachuca Mountains/San Rafael Valley region.

2. In the proposed conservation measures, the Fort has proposed to assist the BLM and other land owners with habitat management or restoration of umbel habitat that has been degraded or lost. Off-post projects that the Fort could consider funding include, but are not limited to, cienega restoration or protection in Scotia Canyon or elsewhere in the Huachuca Mountains, if approved by and coordinated with the landowner(s), and restoration or protection of cienega conditions on the San Pedro RNCA, if approved by and coordinated with the BLM.

3. The Fort could consider having the hydrological models run again to consider the following information: current recharge at the Sierra Vista and Fort Huachuca effluent recharge facilities, storm water recharge on post of 1,040 AF, conservation easements reducing irrigated agriculture by 1,600AF, and current groundwater pumping at Fort Huachuca. Additional model runs should be made to consider the possible scenario for the year 2011: projected population growth in the subwatershed, projected groundwater pumping at Fort Huachuca, and projected recharge at both effluent recharge facilities.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species, the Service requests notification of implementation of any conservation actions.

(Note: research or other activities that result in collection of Huachuca water umbel or parts thereof require appropriate permits from the Service and Arizona Department of Agriculture.)

LESSER LONG-NOSED BAT (*Leptonycteris curosoae yerbabuenae*)

Status of the Species

The lesser long-nosed bat was listed (originally, as *Leptonycteris sanborni*; Sanborn's long-nosed bat) as endangered on September 30, 1988 (USFWS 1988). No critical habitat has been designated for this species. The lesser long-nosed bat is a small, leaf-nosed bat. It has a long muzzle and a long tongue, and is capable of hover flight. These features are adaptations to feed on nectar from the flowers of columnar cactus, such as the saguaro (*Carnegia gigantea*) and organ pipe cactus (*Cereus thurberi*) and from paniculate agaves, such as Palmer's agave (*Agave palmeri*) and Parry's agave (*A. parryi*)(Hoffmeister 1986). Palmer's agave exhibit many characteristics of chiropterophily, such as nocturnal pollen dehiscence and nectar production, light colored and erect flowers, strong floral order, and high levels of pollen protein with relatively low levels of nectar sugar concentrations (Slauson 1996). Parry's agave demonstrates many (though not all) of these same morphological features (Gentry 1982).

The lesser long-nosed bat is migratory and found throughout its historical range, from southern Arizona and extreme southwestern New Mexico, through western Mexico, and south to El Salvador. It has been recorded in southern Arizona from the Picacho Mountains (Pinal County) southwest to the Agua Dulce Mountains (Pima County), southeast to the Chiricahua Mountains (Cochise County), and south to the international boundary. Roosts in Arizona are typically occupied from April to late October (Cockrum and Petryszyn 1991, Sidner 1999); the bat has only rarely been recorded outside of this time period in Arizona (Hoffmeister 1986, Fleming 1995). In spring, adult females, most of which are pregnant, arrive in Arizona gathering into maternity colonies. These roosts are typically at low elevations near concentrations of flowering columnar cacti. After the young are weaned, these colonies disband in July and August; some females and young move to higher elevations, primarily in the southeastern parts of Arizona near concentrations of blooming paniculate agaves. Adult males typically occupy separate roosts forming bachelor colonies. Males are known mostly from the Chiricahua Mountains but also occur with adult females and young of the year at maternity sites (Fleming 1995). Throughout the night between foraging bouts, both sexes will rest in temporary night roosts (Hoffmeister 1986).

As indicated above, the lesser long-nosed bat consumes nectar and pollen of paniculate agave flowers and the nectar, pollen, and fruit produced by a variety of columnar cacti. These bats often forage in flocks. Nectar of these cacti and agaves are high energy foods. Concentrations of some food resources appear to be patchily distributed on the landscape, and the nectar of each plant species utilized is only seasonally available. Cacti flowers and fruit are available during the spring and early summer; blooming agaves are available primarily from July through October. Columnar cacti occur in lower elevation areas of the Sonoran Desert, and paniculate agaves are found primarily in higher elevation desert scrub areas, desert grasslands and shrublands, and into the oak woodland (Gentry 1982). In the Huachuca Mountains, Parry's agave is generally found at higher elevations than Palmer's agave; the former is common in forest openings to the crest of the Huachuca Mountains.

Lesser long-nosed bats appear to be opportunistic foragers and efficient fliers. Seasonally available food resources may account for the seasonal movement patterns of the bat. The lesser long-nosed bat is known to fly long distances from roost sites to foraging sites. Night flights from maternity colonies to flowering columnar cacti have been documented in Arizona at 15 miles, and in Mexico at 25 miles and 38 miles (one way)(Dalton et al. 1994, Yar Petryszyn, University of Arizona, pers. comm. 1997). Fleming (1995) suggests that a substantial portion of the lesser long-nosed bats at the Pinacate Cave in Sonora fly 25 to 31 miles each night to forage in Organ Pipe Cactus National Monument. Horner et al. (1990) found that lesser long-nosed bats commuted 15.5 miles between an island maternity roost and the mainland in Sonora. The authors suggested that bats regularly flew at least 47 miles each night. Lesser long-nosed bats have been recorded visiting individual blooming Palmer's agaves in excess of 1,000 visits per night (Ronnie Sidner, pers.comm., 1997), while other agaves may not be visited at all (Liz Slauson, Desert Botanical Gardens, Phoenix, pers. comm., 1997). Lesser long-nosed bats have been observed feeding at hummingbird feeders many miles from the closest known potential roost site (Yar Petryszyn, pers. comm., 1997).

Loss of roost and foraging habitat, as well as direct taking of individual bats during animal control programs, particularly in Mexico, have contributed to the current endangered status of the species. Suitable day roosts and suitable concentrations of food plants are the two resources that are crucial for the lesser long-nosed bat (Fleming 1995). Caves and mines are used as day roosts. The factors that make roost sites useable have not yet been identified. Whatever the factors are that determine selection of roost locations, the species appears to be sensitive to human disturbance. A single brief visit to an occupied roost has been sufficient to cause a high proportion of lesser long-nosed bats to temporarily abandon their day roost and move to another. Most disturbed bats may return to their preferred roost in a few days. However, this sensitivity suggests that the presence of alternate roost sites may be critical when disturbance occurs. Interspecific interactions with other bat species may also influence lesser long-nosed bat roost requirements.

Known major roost sites include 16 large roosts in Arizona and Mexico (Fleming 1995). According to surveys conducted in 1992 and 1993, the number of bats estimated to occupy these sites was greater than 200,000. Twelve major maternity roost sites are known from Arizona and Mexico. According to the same surveys, the maternity roosts are occupied by more than 150,000 lesser long-nosed bats. The numbers above indicate that although a relatively large number of these bats are known to exist, the relative number of known large roosts is small. Disturbance of these roosts and the food plants associated with them could lead to the loss of the roosts. Limited numbers of maternity roosts may be the critical factor in the survival of this species.

Environmental Baseline

Records of the lesser long-nosed bat at Fort Huachuca and areas within foraging distance of Fort Huachuca (~40 miles) include at least two large post-maternity roosts; observers have recorded more than 15,000 lesser long-nosed bats at a mine in the Coronado National Memorial,

approximately 10 miles from Fort Huachuca, and over 30,000 bats at Patagonia Cave, at a distance of approximately 20 miles from the Fort (Sidner 1996). Other records include: 1) Panama Mine near Pyeatt Ranch on the western boundary of Fort Huachuca, 2) Pyeatt Cave, Fort Huachuca, 3) Manila Mine, Fort Huachuca, 4) Woodcutters Canyon, Fort Huachuca, 5) Wren Bridge, Fort Huachuca, 6) Brown Canyon, Huachuca Mountains, 7) Canelo Mine eight miles west of Fort Huachuca, 8) Miller Canyon, Huachuca Mountains, 9) San Pedro RNCA at Fairbank, 10) Ramsey Canyon, Huachuca Mountains, 11) State of Texas Mine, Coronado National Memorial, Huachuca Mountains, 12) Cave of the Bells, Santa Rita Mountains, 13) Helvetia, Santa Rita Mountains, 14) Madera Canyon, Santa Rita Mountains, 15) Empire Ranch north of Sonoita, 16) several localities near Patagonia, and 17) Colossal Cave, Pima County (Cockrum and Petryszyn 1991, Sidner 1993, 1994, Fleming 1995). Of the above sites, Fleming (1995) considered the Patagonia Bat Cave, Manila Mine, State of Texas Mine, and the Cave of Bells to be major post-maternity roosts of the lesser long-nosed bat. Three major maternity roosts and five major post-maternity roosts are known in Arizona. Post-maternity roosts are typically transitory roosts used by adults or young bats in summer or fall (Fleming 1995). Of the sites at Fort Huachuca, lesser long-nosed bats have been found day roosting at Pyeatt Cave and Manila Mine (some night roosting occurs at these sites as well). Wren Bridge is a night roost, and lesser long-nosed bats were mist-netted in Woodcutters Canyon (Sidner 1994, 1996, 1999). Upper Pyeatt Cave and Indecision Cave are considered potential day roosts, but the species has yet to be documented at these sites (Sidner 1996, 1999). A lesser long-nosed bat banded at Wren Bridge was found the next night at the Patagonia Bat Cave, demonstrating that individuals of this species move relatively long distances and bats at Fort Huachuca are part of a larger regional population (Howell 1996, Sidner 1996).

Annual peak numbers of lesser long-nosed bats observed roosting at roosts on Fort Huachuca have varied from 3,900 in 2000 (Sidner 2000) to 24 in 1990 (Sidner 1992). At Pyeatt Cave numbers have varied from one to over 3,000 roosting lesser long-nosed bats (Sidner 2000). At Wren Bridge small numbers of lesser long-nosed bats have been observed night-roosting under the bridge. Roosting lesser long-nosed bats have been recorded at Fort Huachuca from late June to late November (Sidner 2000). Numbers of bats typically peak in early September (Sidner 1996). Howell (1996) suggests that there are many potential roost sites in the Huachuca Mountains where hundreds of nectar feeding bats could roost without being detected.

Sensitivity of roosting lesser long-nosed bats to human disturbance lead the Fort to close Manila Mine, Pyeatt Cave, and Upper Pyeatt Cave to entry from April 15 through October 31 of each year. Entrances to these are fenced with chain link in a way that inhibits illegal human entry but does not interfere with bats entering or exiting the roosts. The entrances are also posted, and the access roads to Manila Mine and Pyeatt Cave are gated and locked. The access route to Upper Pyeatt Cave is open to the public, but it is a rough, four-wheel drive trail that receives little use, and a live video surveillance system alerts the Fort of illegal entry into Pyeatt Cave and Manila Mine. Thus, the Fort has taken many precautions to ensure that roosting bats are not disturbed. Disturbance of known roosts sites appear to be minimal.

Hunting is allowed in the vicinity of the three known lesser long-nosed bat roosts. Potentially, a hunter could discharge a weapon near a roost site and disturb bats or cause them to temporarily abandon the roost. However, this type of disturbance is likely to be infrequent and most hunting occurs after the bats have left in the fall.

Lesser long-nosed bats require suitable forage plants. At and near Fort Huachuca, forage plants include Palmer's agave and possibly Parry's agave (the two are known to hybridize, as well). Populations of Palmer agave found on the South and West Ranges represent the primary food source for lesser long-nosed bats on Fort Huachuca (Howell and Robinett 1995). Several areas of agave stands on the South and West Ranges are protected and are known as agave management areas (Figure 12). These stands have relatively high densities of agave as compared with other populations across the installation. It is in these areas where training and fire caused by ordnance and small arms discharge are most likely to affect agave populations. Agaves in desert grasslands have evolved with fire, but unnatural, high fire frequency can lead to decline or elimination of agave populations (Howell 1996). Howell (1996) suggests that the natural fire frequency for agave areas on the South Range is probably 10 to 15 years, with a range of 8 to 22 years. Fire frequencies throughout the Fort are shown in Figure 14, and as can be seen, many areas of the West and South ranges have fire frequencies in excess of this.

Sensitive to the need to protect agave stands, the Fort established Agave Management Areas (Figure 12) to protect the largest populations of Palmer's agave. The following range use restrictions apply to Agave Management Areas:

> These training areas, as well as the rest of the South and West Ranges, will be off-limits to all off-road vehicle travel including armor and tracked vehicles;
>
> Pyrotechnics will be banned from use within these areas;
>
> Fires in these areas will be actively suppressed unless the area is approaching its natural fire return interval of 10 years, in which case a prescribed burn may take place. Training and test sites in these areas will not be used by personnel on foot unless the activity has a range control-approved plan for fire suppression and appropriate fire fighting equipment.

These restrictions flow from the "Agave Management Plan (Howell and Robinett 1996) that included the following management recommendations:

1. Establishment of Agave Management Areas;

2. The following management prescriptions would be applied in the Agave Management Areas:

   A. No off-road vehicle activity, including armor and tracked vehicles;
   B. No pyrotechnics;
   C. No tank training in these areas on the West Range;

D. Fire will be actively suppressed unless the area is approaching its natural fire return interval of 10 years; and

E. Training and test sites in these areas will not be used by personnel on foot unless the activity has a range control-approved plan for fire suppression and minimal fire fighting equipment.

Howell and Robinett (1996) further recommended that additional signs informing range users that vehicles must stay on roads and that pyrotechnics are prohibited need to be placed in certain areas, and that military trainers and civilian testers who fail to comply with the measures should be subject to losing their privilege to train at Fort Huachuca. Also recommended was designation of an Agave Protection Coordinator. This coordinator would: 1) serve as a contact point for range users; 2) maintain a data base of reports, regulations, monitoring results, and other printed materials relevant to agaves; 3) develop and distribute to range users an agave information packet that would include a map of agave management areas, the Department of Game Management Environmental Information Fact Sheet, a 1990 video, a brief statement about agaves, and a summary of research activities; 4) visit project sites within agave management areas and prepare a brief statement on effects to agaves; 5) act as a clearing house for research and contract reports on agaves; 6) supervise and provide quality control on surveys and agave research; 7) maintain the Fire Management Plan Burn Map; 8) act as a liaison between the Fort and the Service in regard to agave management; and 9) provide oversight of mitigation.

Other recommendations in Howell and Robinett (1996) include: several measures to make fire protection more effective; protection of the densest stand of agaves in agave management areas if prescribed fire is applied in these areas, only applying prescribed fire from November through March, rotation grazing by horses in a manner that plant communities can recover between uses, fencing of dense stands of agaves in Areas K and H if grazing impacts the population trend of these agave communities, discouragement of foot troops above the platoon size, briefings and environmental awareness materials would be provided to foot troops or civilians on foot that use agave management areas, research and monitoring recommendations, and suggested means for interagency coordination of agave management activities. Implementation of the agave management plan is as yet incomplete. Tom Cochran, Fort Huachuca, (pers. comm., 1998) reports that restrictions (items A-E above) are being followed, but many of the other recommendations, such as appointment of an agave coordinator, environmental awareness training and briefings, and monitoring and inventory recommendations, have not yet been implemented completely.

The Fort employs prescribed fire on the training ranges in areas of high fire danger to reduce fuel loads and thereby reduce chances that fire will spread to Agave Management Areas or other sensitive areas of Fort Huachuca. Existing roads and a series of maintained fire breaks on the bajada and on the lower slopes of the Huachuca Mountains also act to reduce the chance that fire will spread (Robinett et al. 1997)(Figure 6).

Effects of the Proposed Action

The lesser long-nosed bat is most sensitive to activities that might adversely affect roost sites, particularly recreational caving. Other elements of the proposed action may affect foraging habitat or foraging bats, including fire ignited by ordnance, recreationists or other human activities; prescribed or managed natural fire; noise from aircraft or weapons firing; collisions of bats with vehicles, power lines, wind turbines, and other project features; grazing by horses; construction activities that might result in mortality of forage plants; and individual agaves that may be damaged directly by ordnance or by bivouacs or other training activities.

As discussed in the Environmental Baseline, roosting lesser long-nosed bats are very sensitive to human intrusion. Recreational cavers entering Manila Mine, Pyeatt Cave, or other sites where lesser long-nosed bats might day roost could result in temporary or permanent desertion of the roost. However, Manila Mine and Pyeatt Cave (where lesser long-nosed bats have been confirmed), as well as upper Pyeatt Cave (potential habitat) are closed seasonally from April to October when bats may be present. The Fort protects the entrances of these roosts with chain link fence (but the bats can still get through), the entrances are posted, the access roads to Manila Mine and Pyeatt Cave are gated and locked seasonally, the road to Upper Pyeatt Cave is rough and little used, and a live video surveillance system alerts the Fort of illegal entry. Thus, the Fort has taken many precautions to ensure that the bats are not disturbed. However, this type of disturbance is likely to be infrequent and most hunting occurs after the bats have left in the fall.

Of the various components of the proposed action, prescribed or managed fire and wildfire suppression have the greatest potential to adversely affect agaves and forage plant availability. It appears that forage resources are not limiting to lesser long-nosed bat populations in the Huachuca Mountains, or at least it is unlikely (Steidl 2001). Liz Slauson, working at several sites in southeastern Arizona, has never observed agave flowers drained of nectar, suggesting nectar availability is not limiting. However, the bats fly south in September or October at a time when blooming agaves are becoming less and less abundant, suggesting a waning food supply may be one of the factors that trigger migration. Yar Petryszyn (pers. comm., 1999) has observed apparent agonistic behavior of bats at agave flowers late in the season, suggesting possible competition for resources. If forage resources are limiting at times or at certain places, in some years or some areas, numbers of bats may be reduced, or bats may have to fly farther from their roosts to obtain sufficient resources, as a result of insufficient blooming agaves. Bats that fly greater distances are probably more vulnerable to predation or accidental death. Under a scenario of limiting food resources, damage or death of agaves due to prescribed fire could conceivably further reduce forage resources and bat numbers. Although the question of whether agaves are limiting to lesser long-nosed bats in the project area is unanswered, it seems likely that landscape-scale projects, such as a prescribed fire, that are adjacent to important roosts will probably have some effects on bat foraging behavior, and some of these are likely to be adverse effects. The Service considers loss of forage resources a great enough threat to include protection of foraging areas and food plants as a priority 1 task in the lesser long-nosed bat recovery plan.

Mortality of leaf succulents exposed to fire is extremely variable. The Baker prescribed fire was conducted in the southern Peloncillo Mountains in extreme southeastern Arizona and southwestern New Mexico. According to preliminary monitoring efforts conducted after the fire, there were 7 to 11 percent mortality of Palmer's agaves exposed to fire (Peter Warren, pers. comm., 1997). Additional mortality may accrue through loss of the smallest and least detectable size classes of agave. On the Maverick Prescribed Fire, also in the Peloncillo Mountains, less than five percent of agaves in burned areas were killed by the fire. Because of a mosaic of burned and unburned areas, overall mortality in the project area was perhaps less than one percent (T. Roller, pers. comm., 1998). Thomas and Goodson (1992) reported an average mortality of 28 percent of five species of leaf succulents from nine burned sites in southern Arizona. Palmer's agave mortality averaged 18 percent. However, post-fire grazing may have influenced reported mortality. Concentrations of paniculate agaves are primarily on the rocky, shallow soils of hills and ridges, particularly on southerly and southeasterly facing slopes. Other Palmer's and Parry's agaves are found scattered in areas of deep, heavy soils where thick stands of shrubs and mesquite form heavy fuel loads. The relative fuel loading and potential exposure of agaves to intense fire is lower on rocky soils.

Agave mortality due to fire may affect the abundance and distribution of blooming agaves on the landscape for many years, especially if there is high mortality within certain age and size classes (e.g., seedlings). In addition, natural recruitment of agaves may be very episodic and the effects of fire on the agave seed bank in the soil are unknown. Often one of the objectives of prescribed fire is to increase abundance of grasses. Grasses are probably one of the strongest competitors with agave seedlings (Tony Burgess, pers. comm., 1997). Increased abundance of grass could result in reduced agave abundance. Agave stalks, as they begin to bolt, are particularly palatable to domestic livestock and wild herbivores, including deer, javelina, rodents, and rabbits (Michelle Hawks, University of Arizona, pers. comm., 1997; Wendy Hodgson, pers. comm., 1997). Since agaves often remain partially green, succulent, and available to herbivores when food resources are low immediately following a fire, they may be preferentially selected by herbivores. This may in turn affect the availability of agave flowering stalks to bats.

Besides direct mortality of agaves, fire may alter the availability of blooming agaves. By early spring, an agave plant would have physiologically committed to bolt (send up a flowering stalk). If the plant is burned and lives, bolting continues though the flower stalk is smaller with fewer flowers (Howell 1996; L. Slauson, pers. comm., 1997). If the stalk burns directly, the reproductive effort of that plant and the availability of flowers and nectar to *Leptonycteris* has been lost. A fire may actually stimulate flowering in adult agaves one to two years following a burn (L. Slauson, pers. comm., 1997). However, in years following the period of increased flowering there may be a reduced number of flowering agaves. Although the availability of blooming agaves may be affected by fire, the nectar production and sugar content of surviving plants is little effected. Working in the Peloncillo Mountains, Slauson (pers. comm., 1997) found that nectar production and sugar content did not differ between unburned agaves and burned agaves that did not have greater than 80 to 90 percent of the leaf area burned. The complexity of variables influencing agave flowering may mask the effects of a burn on agave flowering within several years of a fire.

Reestablishing fire into fire-adapted communities, such as desert grassland and oak/juniper savanna systems, can also have many benefits and may improve overall long-term "ecosystem management" objectives. Among these is the reduction of woody fuels resulting in decreased probability of intense fires and resulting erosion, soil sterilization, and increased plant mortality. Ultimately, if fire continues to be excluded from fire-adapted systems, a major wildfire will occur with potentially devastating effects. Returning to a more natural regime of low-intensity fires would help to maintain a mosaic of grasslands, woodlands, and shrublands across the landscape and may enhance refugia in which fuel loads and the chances of damaging fires are low. However, even under a prescribed fire regime there are potential adverse effects of fire to forage plants that may affect resource availability for the lesser long-nosed bat.

Activities that directly or indirectly promote invasion or increased density of nonnative grasses, particularly Lehmann lovegrass, may result in increased fire frequency or intensity, reduced densities of Palmer's agave, and thus reduced forage resources for the lesser long-nosed bat. Lehmann lovegrass is abundant in some portions of the West and South ranges at Fort Huachuca. This species increases after fire (Martin 1983, Ruyle et al. 1988, Sumrall et al. 1991, Howell 1996), and also produces an abundance of fine fuel that promotes hot fires (McPherson 1995). Thus, frequent fire is likely to increase the abundance of Lehmann lovegrass, and increased abundance of this grass will likely fuel more fires and hotter fires, creating a positive feedback loop (Anable et al. 1992). Frequent, hot fires brought about by prescribed fires and increasing prevalence of Lehmann lovegrass will likely reduce densities of Palmer's agave. Howell (1996) found that Lehmann lovegrass creates areas of continuous fuels at Fort Huachuca that burn at a constant temperature versus stands of native grasses that are patchy in regard to fuels and fire intensity. Agaves can persist in fire-prone native grasslands in bare areas or refugia that burn lightly or not at all. Such refugia are less common in Lehmann lovegrass stands. Howell (1996) also noted a negative relationship between the proportion of agave seedlings and ramets and the amount of Lehmann lovegrass. She suggested that Lehmann lovegrass appears to suppress agave recruitment independent of the fire effects just described. The mechanism of suppression is unclear, but Howell (1996) suggests Lehmann lovegrass may compete effectively with agaves for nutrients or light. If agave densities are reduced due to elevated fire effects or recruitment suppression caused by Lehmann lovegrass invasion, forage resources of the lesser long-nosed bat will be reduced.

Howell (1996) found that a fire frequency of three to six per decade on the South Range is "clearly too high to allow sexual reproduction to persist in the agave community...too high to permit seedling establishment and too high to allow even the fast-growing clones to achieve reproductive status. Howell (1996) suggested that fires be managed on the South Range to approximate the natural fire frequency, which is likely 10 to 15 years (8-22 range). She also recommended suppressing fires in plots with demography biased toward young or middle age class agaves, because of their sensitivity to fire damage. Examination of Figure 14 reveals that some areas of the South Range, and fewer areas on the West Range, burned six to eight times from 1973 to 1993, which is, according to Howell (1996), too often for healthy agave stands. Most of the West Range, and large portions of the eastern and southern parts of the South Range burned at about the 10 to 15 year frequency recommended by Howell (1996). Overlaying Figure

14 on Figure 12 shows that from 1973 to 1993 the agave management areas on the South Range generally burned more frequently than recommended by Howell (1996). On the West Range, agave management areas generally burned from 0 to 3 times during 1973 to 1993, with most burning less than twice, or generally within the recommendations of Howell (1996). As discussed, the relationship of fire frequency and intensity to agave population dynamics is complex. The Fort has proposed suppressing fires in agave management areas unless the area is approaching its natural fire return interval of 10 years.

The importance of Parry's agave stands in the Huachuca Mountains as a forage resource for the lesser long-nosed bat is unknown. As discussed, Parry's agave generally occurs at higher elevation than Palmer's agave, and occurs in forest openings throughout the Huachuca Mountains to the mountain's crest. Benson and Darrow (1982) note that it typically flowers in June and early July, which is before the lesser long-nosed bat arrives at roosts at Fort Huachuca. However, J. Rorabaugh (pers. comm., 1998) noted many Parry's agave in flower high in the Huachuca Mountains on the crest trail during late July in 1997. It may be that agaves at high elevation bloom later than at lower sites, and could potentially be blooming and be used as a forage resource when lesser long-nosed bats arrive in July or early August.

The only significant threat to stands of agaves in the forested portions of the Huachuca Mountains is fire. As discussed for the Huachuca water umbel and Mexican spotted owl, fuel loads are high in some portions of the Huachuca Mountains, and a stand-replacing, catastrophic wildfire could occur due to lightning strikes or project-related causes such as a recreational use or ordnance. Because Parry's agave occurs primarily in openings and often on rocky slopes where fuel loads are relatively light, agave populations may not be severely directly affected by wildfire. Openings created by fire could conceivably increase habitat for agaves, temporarily. However, post-fire erosion of slopes could bury or scour hillsides and rocky places where agaves occur. The Fort will be implementing a Fire Management Plan to reduce fuel loads and the chance of catastrophic fire in the Huachuca Mountains. With implementation of this plan, threats to agave populations posed by wildfire would be reduced.

Predation of agaves by gophers and ungulates on the West Range was found to be inhibiting sexual reproduction of agaves. Howell (1996) suggested that if areas of the West Range are to be managed for agaves "attention will have to be paid to the intense predation. Predator control (coyotes and other carnivores) has been done on the South Range for 12 to 14 years in an attempt to increase populations of Chihuahuan pronghorn. Reduced predator densities could potentially contribute to increased populations of gophers and ungulates that in turn result in increased predation of agaves. However, Howell (1996) found no correlation between predator control activities and agave demographics on the West versus the South ranges, and predation of agaves appeared to be higher on the West Range where predator control has not been implemented.

Implementation of Howell and Robinett's (1996) agave management plan, as proposed by the Fort, would provide good protection for key agave stands and bat foraging areas in the lower elevation areas of Fort Huachuca. The plan provides for minimizing or eliminating possible adverse effects of training activities, provides a means for fire to play a more natural role without

inhibiting agave population health or viability, and sets up an administrative network and environmental education programs to ensure that protective measures are carried out. However, the Service believes some flexibility should be built into the plan and the recommendation to apply prescribed fire only from November through March in the agave management areas may not be necessary to maintain healthy and viable agave populations. As demonstrated in the Baker and Maverick fires in the Peloncillo Mountains, warm season fire may not result in significant mortality. Exclusion of fire during the warm season could encourage invasion of woody species. However, cool season burns may be warranted to protect small agaves, particularly if Lehmann lovegrass is present, which could increase fire intensity. As discussed, due to uncertainties and the need to make changes as monitoring data and new research results become available, the Service favors an adaptive management approach in which management of key agave stands would evolve with new information.

Howell (1992) examined the effects of UAV (Sky Owl and Hunter) testing on the lesser long-nosed bat at Fort Huachuca. Fort Huachuca proposes testing of the Pioneer and Hunter UAVs; the Pioneer and Sky Owl are both relatively small UAVs and very similar in regard to noise output. Howell (1992) concluded that lesser long-nosed bats would not hear noise of UAVs cruising at 1,000 to 3,000 feet AGL. Currently, typical cruising elevation is above 3,500 feet AGL, with some flights as low as 1,000 feet (and some infrequent low-level flights - see "Effects of the Proposed Action for the Mexican spotted owl). Noise generated by UAVs is relatively low intensity. Also, lesser long-nosed bats are not very sensitive to sounds below frequencies of 10 kHz (Howell 1974). The high frequency sounds to which the bat is sensitive attenuate very rapidly with distance (Howell 1992). Thus, noise generated by typical UAV flights over Fort Huachuca, to the Canelo Hills, the Altar Valley, or other destinations should not disturb foraging or roosting lesser long-nosed bats.

Noise is also generated during rolling or rocket-assisted take off of UAVs. Most proposed UAV take off and landings would occur on the Pioneer and Rugge-Hamilton (formerly Raven) airstrips at the Black Tower Complex on the West Range, but occasional take off and landings would occur at the Hubbard airstrip. The Hunter UAV uses the Rugge-Hamilton strip, whereas the smaller Pioneer uses the Pioneer strip. Howell (1992) concluded that UAV take off at Hubbard airstrip would not affect lesser long-nosed bats because agaves are scarce to nonexistent in that area and the airstrip is over nine miles from known roosts. However, good stands of agaves are present near the Black Tower UAV facility, and bats probably forage near the facility. In regard to rocket-assisted take off, Howell (1992) found that noise generated is well above the minimal noise that triggers a response in the bat's auditory system. She recommended that nocturnal rocket-assisted take off of UAVs from Black Tower only occur from November through May to avoid the season when the bat is present at Fort Huachuca. Howell (1992) also recommended that rocket-assisted take off be attended by fire crews due to the high probability of fire and potential adverse effects to agave communities. The Fort has adopted these recommendations, except that rocket-assisted take off may occur through June. This is an appropriate modification because lesser long-nosed bats have not been recorded at Fort Huachuca before late July. The Fort has also adopted policies calling for nocturnal flights of UAVs to be above 500 feet from July 1 to October 31, and take off and landing approaches at

Rugge-Hamilton and Pioneer airstrips would be modified to avoid flying low-level over agave management areas.

UAVs crash on or off-post about once per year. There have also been two manned aircraft crashes at Fort Huachuca (at Libby Airfield) in the past ten years. Search and rescue operations are carried out for manned aircraft that crash, and aerial or ground searches occur following crashes of UAVs. Some potential exists for aircraft crashes to directly impact agaves or to start fires that affect agaves. The potential for a crash to directly affect a roost site on or off-post is very small.

Disturbance of bats as a result of noise could also occur due to low-level fixed-wing and helicopter flights, small arms or other weapons fire associated with military training, or discharge of a firearm by a hunter. Dalton and Dalton (1993) investigated the effects of low-level (500 feet AGL) military jet flights on the lesser long-nosed bat in a mine that served as a day roost at Organ Pipe Cactus National Monument. Bats exposed to low-level flights exhibited no acute responses (panic flights, falling young bats, or startle responses). No significant differences in bat orienting responses were noted before, during, or after jet flights, but depressed levels of bat flights were noted for up to 30 minutes following the jet noise. Low-level jet noise attenuated rapidly within the roost, particularly the high frequency sounds to which bats are particularly sensitive. The authors note that extrapolation of the results to other sites with different terrain or mine tunnel geometry may not be valid. They also find that the study did not address any potential long-term effects to the bat colony. Wildlife typically respond more to helicopter flights than fixed-wing aircraft. A helicopter flying very low over a bat roost could produce noise as well as high winds that could disturb bats.

The findings of Dalton and Dalton (1993) combined with the apparent infrequency of low-level flights at Fort Huachuca suggest that noise from overflights probably does not significantly adversely affect lesser long-nosed bats that are roosting deep in a mine or cave, at least in the short-term. Low-level nocturnal military flights may affect bats that are foraging or night roosting differently, and as Dalton and Dalton (1993) note, the long-term effects of repeated low-level flights are unknown. Again, however, the infrequency of low-level flights at Fort Huachuca reduces the probability of this being a significant adverse effect.

Hunting is allowed in the vicinity of the three known lesser long-nosed bat roosts. Potentially, a hunter could discharge a weapon near the entrance to a roost site and disturb bats or cause them to temporarily abandon the roost. However, this type of disturbance is likely to be infrequent. Most hunting occurs after the bats have left in late September or early October.

Noise from military weapons fire is unlikely to disturb lesser long-nosed bats. Small arms firing would occur on the South Range; however, the firing ranges are all at least 5.6 miles from Pyeatt Cave and Manila Mine, and over three miles from Wren Bridge. Noise from weapons fire would attenuate dramatically over that distance, particularly the high frequencies. Artillery and mortar firing occurs at several areas on the East Range. Ordnance is directed eastward from these sites

and is delivered into Area ZULU, also on the East Range. Noise from these sources is louder than the small arms firing on the West Range. However, mortar and artillery firing on the East Range occur at a much greater distance from the known bat roosts. All mortar and artillery firing sites and the impact zone in Area ZULU are more than 6.2 miles from Wren Bridge and more than 7 miles from Pyeatt Cave and Manila Mine. No effects to lesser long-nosed bats are anticipated as a result of mortar and artillery firing on the East Range.

Mortality or injury of lesser long-nosed bats could also occur due to collisions with vehicles, wind turbines, antennas, aircraft, ordnance, power and communications lines, or other project features on Fort Huachuca. The frequency of such collisions is unknown, but the Service believes this type of take is likely to occur at least once over the life of the project. The Fort has proposed no nighttime training in agave management areas from July 1 through October 31, no nighttime use and no tracer fire on live fire ranges 2, 3, and 4 from July 1 through October 31, no use of pyrotechnics within 0.25 mile of agave management areas, and no off-road vehicle use and restrictions on low-level flights nocturnal over agave management areas, which collectively greatly reduce the likelihood of take resulting from collisions.

Cattle grazing can adversely affect agave survivorship and bolting. Before the summer monsoons at Four Peaks on Tonto National Forest, cattle were observed eating the unprotected apex of several agave plants (Tricia Roller, pers. comm., 1997). Cattle probably trample young agaves, as well. Although cattle have been excluded from Fort Huachuca for many years, grazing by horses occurs on 1,433 acres of the West Range within 0.6 mile of protected agave stands and Wren Bridge. The horse pastures are about three miles from Manila Mine and Pyeatt Cave. Thus, the grazed area is likely foraging habitat for the lesser long-nosed bat. There are some differences in grazing behavior between horses and cattle. It is unknown whether horses browse agave bolts, but if they do, forage resource availability for the bat would be reduced by such browsing. Horses, like cattle, probably also trample young agaves and may compact soils and reduce germination and survival. Although horses tend to avoid areas of high densities of agaves (Howell and Robinett 1996), any trampling or browsing of agaves would reduce forage resources available to the lesser long-nosed bat. Direct effects due to grazing may be more intense in areas grazed during the flowering season of the agave (primarily Area C) and where horses congregate near water sources.

The Fort proposes a number of building and construction projects over the next 12 years (Table 3). Most of these would occur in the cantonment area in previously disturbed areas, or would be improvements to existing structures. Few if any of these projects have potential to disturb habitats that may contain agaves. An exception may be the recreational vehicle park expansion on the northwestern side of the cantonment area. However, the expansion is small, and any effects to bat forage resources at Fort Huachuca would be relatively very small. The Fort is also proposing to build a new ammunition supply point in 2011. The project would disturb about 25 acres of grassland on the south range where few, if any, agave are known to occur. The Fort has adopted measures to ensure minimal disturbance of lesser long-nosed bat foraging habitat during construction.

Some training, such as bivouacs, ordnance delivery, and other activities that may result in disturbance could damage or destroy agaves, or result in soil compaction and reduced agave establishment. However, personnel are instructed to avoid disturbance to agaves, nearly all such training occurs at established sites or previously-disturbed areas, areas directly disturbed by ordnance delivery are relatively small (fire effects of ordnance delivery are discussed above), the most significant stands of Palmer's agave are well-protected from training activities in the agave management areas, and very little training occurs in the habitat of Parry's agave.

The Fort proposes to exchange a 26-acre parcel near Kayetan Drive and Buffalo Soldier Trail to the Arizona State Land Department for in-holdings in the East Range. State land parcels in the East Range probably have little development potential because of their location in an active military range. However, the 26 acres which may be exchanged to the state could be developed. The City of Sierra Vista planning department indicates that the most likely use of the land is commercial or light industrial (Jim Hessil, pers. comm., 1998). If all or part of the 26-acre parcel is developed, some foraging habitat of the bat could be lost. It is unknown whether agaves occur on the parcel, but it is rather low on the bajada where agaves are uncommon or absent.

A related land exchange is also being planned to gain full title to several parcels of land on the East Range of the Fort. In cooperation with the BLM and the State of Arizona, state trust lands may be exchanged to ensure that full title to those parcels is conveyed to the Federal government. This administrative action will not change land use or activities on those inholdings.

The City of Sierra Vista has proposed to acquire from Fort Huachuca 203 acres adjacent to Libby Airfield pursuant to the Airport Improvement Act. The land would be used for aviation-related uses. This action is currently set aside (Appendix D of BA). If this realty action is proposed in the future, it will be the subject of separate section 7 consultation.

Off-post activities are unlikely to affect lesser long-nosed bats or their habitat. These activities occur in previously-disturbed areas. As discussed for the southwestern willow flycatcher, activities off-post could potentially increase the chances of fire, which may adversely affect agave plants and bat forage resources. Also, some off-post training activities involve use of antennas with which bats might collide, and vehicles traveling to and from remote sites could potentially collide with a foraging lesser long-nosed bat. However, the Fort has several conservation measures in place to reduce the chance of this occurring (see Section 5 of BA).

Interrelated and Interdependent Effects

As discussed for the Huachuca water umbel and the southwestern willow flycatcher, some of the existing development and population in the Sierra Vista area can be attributed to Fort Huachuca, because some employees, contractors, military dependents, military retirees, and others live in the Sierra Vista area because of job opportunities or military benefits provided by the Fort (DRM 1997). Thus, some of the residents and development off-post would not be there but for the presence of Fort Huachuca. Some of this development may have resulted in destruction of lesser

long-nosed bat foraging habitat. However, the best agave populations appear to be concentrated on the upper bajadas, while most of the development has occurred lower on the slope where agaves are uncommon. Also, as discussed for the umbel, predicted growth in the Sierra Vista area may not be attributable to Fort Huachuca because number of personnel at the Fort is proposed to be level over the near term (ENRD 2002).

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (state, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions would be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed project. Effects of past Federal and private actions are considered in the Environmental Baseline.

Much of the land in the project area is managed by Federal agencies, particularly the BLM, Coronado National Forest, and Coronado National Memorial. The only significant known roost in the Huachuca Mountains outside of Fort Huachuca is the State of Texas Mine on the Coronado National Memorial. Activities on state and private lands may require permits or funding from Federal agencies. Thus, many of the actions that are reasonably expected to occur in the project area that may adversely affect the lesser long-nosed bat would be subject to section 7 consultation. However, grazing, development, and other activities occur on large tracts of state and private lands within the project area and within the known range of the lesser long-nosed bat that are not interrelated or interdependent to the Fort's activities and are not otherwise subject to section 7. The effects of these activities are considered cumulative to proposed action. Development near the base of the Huachuca Mountains or at the mouths of canyons on the east slope south of Fort Huachuca could result in destruction of bat foraging habitat and agaves. Compliance with the Act for activities on state and private lands that may affect the lesser long-nosed bat, but are not addressed by section 7 consultation, could occur through section 10(a)(1)(B) of the Act.

Effectiveness of Proposed Conservation Measures

The Service and the Fort have exchanged considerable correspondence over the last decade on lesser long-nosed bat concerns. As a result, the Fort has developed many valuable measures to protect the lesser long-nosed bat and its habitat. We recommended some of these measures to the Fort to reduce the likelihood of take; they were subsequently adopted by the Fort as part of their proposed action. Others have been in place for many years. These measures are found in section 5 of the BA and can be summarized as follows:

1. The Fort will ensure that construction, upgrading, or maintenance of roads does not increase or facilitate public access to Manila Mine, Pyeatt Cave, or other day roosts identified during the life of the project.

2. The Fort is in the process of installing a new surveillance system because the previous system was unreliable. The system will be operational by July 2002. Access routes at the closures and the mine/cave sites are posted with the following information: no vehicle access, no entry into mines or caves, explanations that the closures are needed to protect sensitive species, and warnings that entry into the mines/caves could represent a violation of the ESA. Fort Huachuca will continue to maintain the signs. Current access control will continue with no access from July 1 to October 31unless bats are present which would expand the closure period.

3. Monitoring will be conducted following Section 5.4.4 of the BA.

4. The Fort will prohibit low-level helicopter flights within 350 feet of Pyeatt Cave, Manila Mine, or other day roosts identified during the life of the project from July 1 to October 31, unless bats are present which would expand the prohibition.

5. Before construction activities, pre-construction surveys will be conducted for paniculate agaves that may be directly affected by construction activities. If agaves are found during pre-construction surveys, the following measures will be implemented:

a. Disturbance will be limited to the smallest area practicable, damage to agaves will be avoided where possible, and projects will be located in previously disturbed areas whenever possible.

b. Vehicle use will be limited to existing routes and areas of disturbance except as necessary to access or define boundaries for new areas of construction or operation.

c. All workers will strictly limit their activities and vehicles to designated areas. Construction workers will be informed of these terms and conditions.

6. No seeding or planting of nonindigenous grasses or other plants will occur at Fort Huachuca that may alter fire frequencies in wildland areas. However, seeding with proven hybrid sterile seeds in disturbed construction sites is authorized to establish a temporary ground cover for erosion control. This is only authorized during fall and spring when it is not feasible to seed with native species.

7. General fire coordination will be accomplished as specified in Section 5.4.7 of the BA. Also, the following measures will be implemented:

a. Prescribed fire and managed natural fire will be planned to minimize adverse effects to lesser long-nosed bat forage plants and roosts. Measures will be developed to ensure the following:

1) The fire kills no more than 20% of agaves that are burned during prescribed fire or managed natural fire.

2) Fires in agave management areas will be actively suppressed unless the area is approaching its natural fire return interval of 10 years.

3) Prescribed fire will be prohibited in agave management areas where greater than half of those agaves are young age classes (agaves with four or fewer spiral courses of leaves).

4) A mitigation plan will be developed by the Fort in coordination with the Service for each prescribed or managed natural fire within 0.5 mile of a lesser long-nosed bat roost or in areas that support paniculate agaves. The mitigation plan will ensure those effects to lesser long-nosed bat roosts and forage plants are minimized and will include monitoring of effects to forage plants. The Service will approve the plan in writing. Mitigation and monitoring for managed natural fire will be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

5) A schedule for prescribed burns will be established and followed to reduce fuel loading in Fort Huachuca grasslands and woodlands, thereby reducing the potential for major wildfires in lesser long-nosed bat foraging and roosting habitat. This schedule will be coordinated and approved by the Service in writing.

6) Nighttime training will not occur in agave management areas from July 1 through October 31.

8. No nighttime use and no tracer fire will occur on live fire ranges 2, 3, and 4 from July 1 through October 31.

9. From July 1 through October 31, all nocturnal UAV operations at the Rugge-Hamilton and Pioneer sites will be above 500 feet AGL, except for take off and landings. Take off and landing approaches at Rugge-Hamilton will be confined to the east and north and approaches at Pioneer will be confined to the north and west, away from agave management areas. Nocturnal rocket-assisted take off of UAVs from the Black Tower site will only occur from November through June. Rocket-assisted take off will be attended by fire crews due to the high probability of fire and potential adverse effects to agave communities.

10. Off-road vehicle travel will not occur in protected agave management areas or any other part of the West Range or South Range.

11. Pyrotechnics will not be used within 0.25 mile of protected agave management areas.

12. The Fort will develop an endangered species management plan for the lesser long-nosed bat by June 2003.

13. The Fort will monitor Palmer's agave populations on the West and South Ranges every five years. The objective of the monitoring will be to establish trends in bat forage resources.

14. Fort Huachuca will continue to monitor around the Bergey wind turbine and wind data towers. If Lesser long-nosed bats are found dead at the base of these structures, the Fort will stop operation of the wind turbine and contact the Service immediately.

15. The Fort will monitor take of lesser long-nosed bats, document any disturbance of roost sites, and document acres burned on the West or South ranges and whether such fire burned in agave management areas. The results of this monitoring will be reported to the Service following the reporting requirements in the proposed action.

The Service believes the above measures will largely reduce or eliminate most potential adverse effects to the lesser long-nosed bat as a result of the proposed action. Gating, signing, and restricting access seasonally has been successful in nearly eliminating human disturbance at bat roosts. However, the current system does not prevent illegal entry to bat roosts. By the time the alarm system detects an intruder and military police can respond, considerable disturbance to the bats may have already occurred. Bat gates with lockable human access doors would be more effective and eliminate the need for an alarm system; however, we are concerned about the possible effects that bat gates may have on use of roosts by lesser long-nosed bats. Gating designs are being tested at the State of Texas Mine at Coronado National Memorial and should provide further insight into how bat gates should be used for this species.

Noise from aircraft and weapons fire is regulated, too distant from bat roosts or foraging areas, or in the case of low-level helicopter flights, is infrequent enough to be minimally disturbing to lesser long-nosed bats. By not operating UAVs at night below 500 feet above ground level from July 1 to October 31, the Fort has implemented Howell's (1992) recommendations in regard to UAV flights. The most important stands of Palmer's agave are protected from too-frequent fire and training activities by a variety of measures.

As discussed in the Effects of the Proposed Action in regard to fire in agave management areas, we believe the relationships between fire frequency, intensity, and seasonality and agave population dynamics are complex. The recommendations of Howell and Robinett (1996)(Agave Management Plan) as to how agave management areas should be managed are generally a good starting point, but we believe the Fort should practice adaptive management and use monitoring data and research results to further fine tune these recommendations. Howell and Robinett's

(1996) recommendation to not burn during the warm season in agave management areas is probably not warranted in most areas, based on findings in the Peloncillo Mountains. However, cool season burns may be needed in specific sites to protect younger size classes of agaves, particularly if Lehmann lovegrass is common.

The timing or seasonality of when specific mitigation measures would apply is July 1 through October 31. This encompasses the period when lesser long-nosed bats have been observed at Fort Huachuca (July 6-October 22). Numbers typically peak in early September (Sidner 1999). Fleming (1995) notes that male lesser long-nosed bats arrive at East Whitetail Canyon in the Chiricahua Mountains as early as late April; however, Sidner (1996, 1999) has monitored roosts at Fort Huachuca in May and June without finding lesser long-nosed bats. Sidner's roost surveys suggest that a sensitive period for the bat, when activities should be actively managed to protect roosts and foraging bats, should be July 1 to October 31, as proposed by the Fort. Closure of roosts to cavers earlier in the season may be appropriate to protect other non-listed species of bats that arrive sooner, such as pallid bats (*Antrozous pallidus*) and *Myotis velifer.*

Conclusion

After reviewing the current status of the lesser long-nosed bat, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the lesser long-nosed bat. No critical habitat has been designated for the lesser long-nosed bat; thus none will be affected. We present this conclusion for the following reasons:

1. The proponent's proposed action includes many features to minimize take of lesser long-nosed bats and mitigate the direct and indirect impacts of the proposed action on the lesser long-nosed bat and its foraging and roosting habitats;

2. The project area in which most activities occur covers a relatively minor portion of the total range of the lesser long-nosed bat.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out an

otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Fort Huachuca so that they become binding conditions of any grant or permit issued to any applicant, permittee, or contractor, as appropriate, for the exemption in section 7(o)(2) to apply. The Fort has a continuing duty to regulate the activity covered by this incidental take statement. If the Fort (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant, permittee, or contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, Fort Huachuca must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

Amount or Extent of Take

The Service anticipates the following incidental take of lesser long-nosed bats as a result of authorized activities that are part of the proposed action:

1) Six lesser long-nosed bats over the life of the project in the form of direct mortality or injury as a result of collisions with vehicles, aircraft, antennas, fences, and other project features;

2) Twenty lesser long-nosed bats per year as a result of harassment due to noise associated with military training, hunter weapons fire, and military overflights;

3) Ten lesser long-nosed bats over the life of the project as a result of harm due to loss of forage plants due to prescribed fire, wildfire suppression, wildfire caused by authorized activities, grazing by horses as described in the proposed action, construction activities, training, and subsequent development on a 26-acre parcel proposed for exchange; and

The Service believes take of lesser long-nosed bats will be difficult to detect for the following reason(s): the bat is wide-ranging and may use more than one roost; it has a small body size; thus finding a dead or impaired individual is unlikely; losses may be masked by seasonal use of roosts; and the species occurs in habitats that make detection difficult.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. This biological opinion does not authorize any form of take not incidental to the Fort's proposed action as described herein.

Effect of the Take

In this biological opinion, the Service finds that this level of anticipated take is not likely to jeopardize the continued existence of the lesser long-nosed bat.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize impacts of incidental take authorized by this biological opinion:

1. Fort Huachuca shall continue to monitor the lesser long-nosed bat and its habitat to document levels of take and determine effectiveness of conservation measures.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Fort must comply with the following term and condition in regard to the proposed action. This term and condition implements the reasonable and prudent measure described above. Terms and conditions are nondiscretionary.

1. The following terms and conditions implement reasonable and prudent measure number one:

1.1. Fort Huachuca shall continue to monitor lesser long-nosed bat populations and forage resources;

1.2. Fort Huachuca shall prepare an annual report which summarizes the implementation of the proposed action and any incidental take that occurred. The Service is especially interested in an analysis of the effectiveness of the conservation measures and terms and conditions.

If the incidental take anticipated in the paragraph entitled "Amount or Extent of Take is met, the Fort shall immediately notify the Service in writing. If, during the course of the action, the level of anticipated incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation. In the interim, the Fort must cease the activity resulting in the take if it is determined that the impact of additional taking will cause an irreversible and adverse impact on the species. Fort Huachuca must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendations provided here do not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the lesser long-nosed bat. In furtherance of the purposes of the Act, we recommend consideration of the following actions:

1. The Fort could investigate the importance of Parry's agave as a forage resource for the lesser long-nosed bat.

2. The Fort could continue to investigate the fire ecology of paniculate agaves.

3. The Fort could investigate and monitor the invasion of Lehmann lovegrass at Fort Huachuca and assist other agencies in developing methods for controlling this nonnative grass.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitat, the Service requests notification of the implementation of any conservation recommendations.

(*Note: surveys for lesser long-nosed bats, or other bats, that involve capture or take require appropriate permits from the Service and Arizona Game and Fish Department.*)

MEXICAN SPOTTED OWL (*Strix occidentalis lucida*)

Status of the Species

The Mexican spotted owl was listed as threatened on March 16, 1993 (USFWS 1993). Critical habitat was designated for the species on June 6, 1995 (USFWS 1995b), but was withdrawn (USFWS 1998). No lands at Fort Huachuca or in the Huachuca Mountains were designated critical habitat in the 1995 final rule. Critical habitat was redesignated in 2001 and included Fort Huachuca (USFWS 2001a). The Mexican spotted owl was originally described from a specimen collected at Mount Tancitaro, Michoacan, Mexico, and named *Syrnium occidentale lucidum.* The spotted owl was later assigned to the genus *Strix*. Specific and subspecific names were changed to conform to taxonomic standards and the subspecies became *S. o. lucida.* The American Ornithologists' Union currently recognizes three spotted owl subspecies, including the California (*S. o. occidentalis*), Mexican, and Northern (*S. o. caurina*). The Mexican spotted owl is mottled in appearance with irregular white and brown spots on its abdomen, back, and head.

The spots of the Mexican spotted owl are larger and more numerous than in the other two subspecies giving it a lighter appearance. Several thin white bands mark an otherwise brown tail. Unlike most owls, spotted owls have dark eyes.

The Mexican spotted owl is distinguished from the California and Northern subspecies chiefly by geographic distribution and plumage. The Mexican spotted owl has the largest geographic range of the three subspecies. The range extends from the southern Rocky Mountains in Colorado and the Colorado Plateau in southern Utah southward through Arizona and New Mexico and, discontinuously through the Sierra Madre Occidental and Oriental to the mountains at the southern end of the Mexican Plateau.

Using starch-gel electrophoresis to examine genetic variability among the three subspecies of spotted owls, Barrowclough and Gutierrez (1990) found the Mexican spotted owl to be distinguishable from the other two subspecies by a significant variation, which suggests prolonged geographic isolation of the Mexican subspecies and indicates that the Mexican spotted owl may represent a species distinct from the California and Northern spotted owls.

The current known range of the Mexican spotted owl extends north from Aguascalientes, Mexico through the mountains of Arizona, New Mexico, and western Texas, to the canyons of southern Utah and southwestern Colorado, and the Front Range of central Colorado. Although this range covers a broad area of the southwestern United States and Mexico, much remains unknown about the species' distribution within this range. This is especially true in Mexico where much of the owl's range has not been surveyed. Information gaps also appear for the species' distribution within the United States. It is apparent that the owl occupies a fragmented distribution throughout its United States range corresponding to the availability of forested mountains and canyons, and in some cases, rocky canyon lands.

The primary administrator of lands supporting owls in the United States is the Forest Service. According to the Recovery Plan, 91 percent of owls known to exist in the United States between 1990 and 1993 occur on land administered by the Forest Service (USFWS 1995c). The majority of known owls have been found within Region 3 of the Forest Service, which includes 11 National Forests in New Mexico and Arizona. Forest Service Regions 2 and 4, including two National Forests in Colorado and three in Utah, support fewer owls.

The range of the Mexican spotted owl in the United States has been divided into six recovery units (RUs) as discussed in part II.B. of the Recovery Plan for the Mexican Spotted Owl (Recovery Plan)(USFWS 1995c). An additional five RUs were designated in Mexico. While the Recovery Plan provides distribution, abundance, and density estimates by RU, a reliable estimate of the numbers of owls throughout its entire range is not currently available due to limited information. Owl surveys conducted from 1990 through 1993 indicate that the species persists in most locations reported before 1989, with the exception of riparian habitats in the lowlands of Arizona and New Mexico, and all previously occupied areas in the southern states of Mexico. Increased survey efforts have resulted in additional sightings for all recovery units.

Fletcher (1990) calculated that 2,074 owls existed in Arizona and New Mexico in 1990 using information gathered by Region 3 of the Forest Service. Fletcher's calculations were modified by McDonald et al. (1991), who estimated that there was a total of 2,160 owls in the United States. Ganey (1998) estimated 600 to 1,200 Mexican spotted owls inhabit Arizona. However, these numbers are not reliable estimates of current population size for a variety of statistical reasons. While the number of owls throughout the range is currently not available, the Recovery Plan reports an estimate of owl sites based on 1990 to 1993 data. An owl "site" is defined as a visual sighting of at least one adult owl or a minimum of two auditory detections in the same area in the same year. Surveys from 1990 through 1993 indicate one or more owls have been observed at a minimum of 758 sites in the United States and 19 sites in Mexico. The greatest concentration of known owl sites in the United States occurs in the Upper Gila Mountain recovery unit (55.9%), followed by the Basin and Range-East (16.0%), Basin and Range-West (13.6%), Colorado Plateau (8.2%), Southern Rocky Mountain-New Mexico (4.5%), and southern Rocky Mountain-Colorado (1.8%) RUs.

Past, current, and future timber-harvest practices in Region 3 of the Forest Service, in addition to catastrophic wildfire, were cited as the primary factors leading to listing of the spotted owl as a threatened species. Fletcher (1990) estimates that 1,037,000 acres of habitat were converted from suitable (providing all requirements of the owl, e.g., nesting, roosting, and foraging) to capable (once suitable, but no longer so). Of this, about 78.7 percent, or 816,000 acres, was a result of human management activities, whereas the remainder was converted more or less naturally, primarily by wildfire. Other factors which have or may lead to the decline of this species include a lack of adequate regulatory mechanisms. In addition, the Recovery Plan notes that forest management has created ecotones favored by great horned owls, and there is, as a result, an increased likelihood of contact between spotted owls and great horned owls (a potential competitor and predator). Increases in scientific research, birding, educational field trips, and agency trips are also likely to occur. Finally, there is a potential for increasing malicious and accidental anthropogenic harm. Based on short-term population and radio-tracking studies, and longer-term monitoring studies, the probability of an adult Mexican spotted owl surviving from one year to the next is 0.8 to 0.9. Juvenile survival is considerably lower at 0.06 to 0.29, although it is believed these estimates may be artificially low due to the high likelihood of permanent dispersal from the study area and a period of several years before marked juveniles reappear as territory holders and are detected as survivors through recapture efforts (White et al. 1995). Little research has been conducted on the causes of mortality of the spotted owl, but predation by great horned owls, northern goshawks, red-tailed hawks, and golden eagles; starvation; and accidents or collisions may all be contributing factors.

Little is known about the reproductive output for the spotted owl. It varies both spatially and temporally (White et al. 1995), but the subspecies demonstrates an average annual rate of 1.001 young per pair. There is inadequate data at this time to estimate population trend. Little confidence in initial estimates has been expressed, and is due to its reliance on juvenile survival rates which are believed to be biased low, and due to the insufficient time period over which studies have been conducted.

In 1996, the Fish and Wildlife Service issued a biological opinion on Forest Service Region 3's adoption of the Recovery Plan recommendations through an amendment of their Forest Plans. In this non-jeopardy biological opinion, we anticipated that about 151 PACs would be affected by activities that would result in incidental take of MSOs, with 26 of those PACs located in the Basin and Range West RU. To date, consultations on individual actions under the amended Forest Plans have resulted in 111 PACs adversely affected, with 36 of those in the Basin and Range West RU.

In addition to actions proposed by the Forest Service, we have also reviewed the impacts of actions proposed by the Bureau of Indian Affairs, Department of Defense (including Air Force, Army, and Navy), Department of Energy, National Park Service, and Federal Highway Administration. These proposals have included timber sales, road construction, fire and ecosystem management projects (including prescribed natural and management ignited fires), livestock grazing, recreation activities, utility corridors, military and sightseeing overflights, and other activities. Only one of these projects (release of site-specific owl location information) has resulted in a biological opinion that the proposed action would likely jeopardize the continued existence of the MSO. In total, we have anticipated that approximately 271 PACs would be adversely impacted by Federal actions, with 72 of those in the Basin and Range West RU.

Environmental Baseline

The Huachuca Mountains and Fort Huachuca are included in the Basin and Range -West RU, which is characterized by mountain ranges isolated by desert basins. This RU along with the Upper Gila Mountains and the Basin and Range - East RUs are believed to be important habitat because of the high number of spotted owls relative to the other RUs (USFWS 1995c). The Basin and Range-West RU includes most of southern Arizona and a small part of southwestern New Mexico. Owl territories occur in both heavily forested terrain and areas with hardwood and conifer stringers dominated by Madrean Evergreen woodland. The subpopulation occurs in widely distributed territory clusters of varying sizes. The Sky Island Division (includes the Huachuca Mountains) may represent an important demographic link between the Mogollon Province demes and those in the Sierra Madre Occidental. Demographic persistence and connectivity within the Division and between divisions may be hindered by the compounding factors of naturally disjunct habitat and long dispersal distances.

The risk of habitat loss due to catastrophic wildfire is moderately high. In the past six years, the Noon, Arcadia, Clark Peak, Oversight, Merritt, Bullock, and Lone Fires have resulted in the loss of Mexican spotted owl habitat within this RU. A large, widespread fire in 1899 was the first of a series of stand-replacing fires in the Huachuca Mountains during the last century. Recent stand-replacing fires have occurred in the Huachuca Mountains in the vicinity of Carr Peak (1977) and Pat Scott Peak (1983) and elsewhere (Merritt and Oversight fires 2002)(Danzer 1997). Although the Coronado National Forest does not have an active timber program, localized projects in the Huachucas and other ranges in the Sky Island Division, such as road construction, mining, and other construction may adversely affect the owl or its habitat.

The habitat characteristics of Mexican spotted owl nesting and roosting sites generally consist of multi-layered, uneven-aged forests with high canopy closure or rocky, shaded canyons (USFWS 1995c). In the Huachuca Mountains, many spotted owl nest sites were described as Madrean pine-oak woodland with montane conifer species and some broadleaf riparian component (Duncan 1991). Cliffs are present at some sites and used for nesting.

Within the Basin and Range-West RU, spotted owls have been located in rocky canyons or in several forest types at elevations ranging from 3,690 to 9,610 feet of the Atascosa-Pajarito, Santa Rita, Santa Catalina, Patagonia, Whetstone, Galiuro, Huachuca, Chiricahua, Pinaleno, Superstition, Sierra Ancha, Mazatzal, and Bradshaw Mountains, Arizona. Below 4,264 feet spotted owls were found in steep canyons containing cliffs and stands of live oak, Mexican pine, and broad-leaved riparian vegetation (Ganey and Balda 1989). Above 5,904 feet, spotted owls were found in mixed conifer and pine-oak forests. Mid-elevation observations included sites with Arizona cypress and the other forest types previously mentioned (USFWS 1995b).

Twenty-seven spotted owl management territories are known from the Huachuca Mountains, including eight on Fort Huachuca and 19 on Coronado National Forest lands to the south of the Fort (Duncan 1999, ENRD 2002, Service files). Russell Duncan monitored, banded, and collected blood samples from Mexican spotted owls on Fort Huachuca from 1990 to 1999. Since 2000, the Fort has contracted with EEC for annual monitoring and inventory efforts on the installation. Results of all known Mexican spotted owl surveys on Fort Huachuca are reported in Table 10. In 1996, SAIC (1998a) conducted, in accordance with Service protocol, surveys of all

suitable habitat on the South Range that did not contain previously identified spotted owl territories. No new territories were located.

About 16 percent of the South Range was classified as potential habitat. In 1997, potential habitats on Fort Huachuca were surveyed four times. Duncan (1997) found breeding pairs of owls only in McClure and upper Huachuca Canyons. A pair of owls in Scheelite Canyon did not breed in 1997. In 1998, Mexican spotted owls were detected in McClure, Upper and Lower Huachuca, and Scheelite Canyons. Only the pair in Huachuca Canyon reproduced (Duncan 1999). Surveys are incomplete for 1999, but Service personnel observed a pair of spotted owls in Scheelite Canyon in late June 1999. The Service's policy is that potential nest/roost habitat is considered inadequately surveyed if more than one breeding season has elapsed since the last year of survey to protocol. The Service therefore considers inadequately surveyed habitat to be occupied by Mexican spotted owl. Follow-up surveys consisting of an additional year of survey (4 visits) must occur before actions that may effect the owl or its habitat. Spotted owls have been detected at Fort Huachuca during winter in Tinker Canyon (Duncan 1993). They may be found at lower elevation sites in the Huachuca Mountains when not nesting.

Eight "protected activity centers (PACs) have been identified at Fort Huachuca (Table 10). PACs are nest sites, a roost grove commonly used during the breeding season in absence of a verified nest site, or the best roosting and nesting habitat if both nesting and roosting information

Table 10. Mexican spotted owl site occupancy at Fort Huachuca, Arizona, from 1990 to 2001, with notes on reproduction (from Duncan 1999, ENRD 2002).

PAC	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Rock Springs Canyon Trail 5001001	ND	O, 1Y	O, 2Y	0, NN	O, NN	O, NN	O, 1Y	A	A	A	A	A
McClure Canyon 5001002	ND	O, 1Y	O, 3Y	O, NN	O, NN	O, NN	O, NF	O, 2Y	O, NN	O, NN	O, NU	1M, 1F
Huachuca Canyon Upper 5001003	ND	O, NU	O, 1Y	O, NN	O, NN	O, NN	O, NN	O, 2Y	O, 1Y	O, NN	O, 1Y	O, 2Y
Woodcutter Canyon 5001004 [1]	O, NN	A	O, NU	A	A	A	A	A	A	A	ND	ND
Scheelite Canyon 5001005	O, NN	O, 2Y	O, NN	O, NN	O, NN	O, 1M	O, NN+ M	O, NN	O, NN	O, NN	O, NU	O, 2Y
Split Rock Canyon 5001006	ND	O, NF	O, NN	O, NN	O, NN	O, NN	M	A	A	A	A	A
Blacktail Canyon 5001007	ND	A	A	A	A	A	M	A	A	A	A	A
Huachuca Canyon Lower 5001008	ND	A	A	A	A	A	A	A	O, NU	A	0,2Y	O, NN

[1] Woodcutters Canyon designated as unsuitable habitat for MSO (S. Stone, pers. com., 2001)

O - Pair Occupancy inferred or confirmed
M - Male inferred or confirmed
F - Female inferred or confirmed
P - Presence of lone inferred or confirmed, sex unknown
NF - Nest failed
A - Absent or unoccupied
ND - No Data
NU - Nesting status undetermined
NN - Non-nesting
NA - Nest Abandoned
Y - Number of young fledged
YD - Number of young found dead

are lacking. There are three IAs on Fort Huachuca in addition to the eight PACs. IAs are potential foraging, nesting or roosting habitats. In the Basin and Range-West RU, owl management is based on PACs to ensure that all Mexican spotted owl sites known from 1989 through the life of the Recovery Plan are protected. PACs are areas of no less than 600 acres that enclose the best owl habitat in the area, with the nest or activity center near the center. There are 4,270 acres delineated as Mexican spotted owl PACs currently on Fort Huachuca. All eight PACs occur in the higher elevations of the Fort in the Huachuca Mountains. The Fort is currently outlining an Endangered Species Management Plan (ESMP) for this species and its habitat.

Over the past 11 years of monitoring, occupancy for eight PACs ranged from as low as 25 percent to as high as 75 percent. Occupancy percentage was determined by dividing total number of subject areas by the number of subject areas with confirmed or inferred occupancy. Reproductive output has ranged from as low as 0 percent to as high as 66 percent over the same period (EEC 2001c). Reproductive output was determined by dividing the total number of pairs inferred or confirmed by the total number of pairs confirmed with successful reproduction.

Seven PACs and two Inventory Areas (IAs) were monitored during 2001 with 66 percent overall occupancy. There was successful reproduction of two out of the six confirmed or inferred pairs for a total of 33 percent reproductive output. One pair of Mexican spotted owls was observed nesting on Coronado National Forest lands next to the installation and foraging on installation land while a second pair was believed to foraging and protecting territory in Upper Scheelite Canyon but is a resident pair found in Brown Canyon on Coronado National Forest land (EEC 2001c).

Effects of the Proposed Action

Potential threats to the owl include noise, fire, human disturbance, and direct mortality at Fort Huachuca (SAIC 1998a, ENRD 2002). Owl territories and PACs are located in the canyons of the Huachuca Mountains where ground-based military training is limited primarily to existing routes of travel. Most human use of these areas is light and limited primarily to recreational pursuits such as birding, hunting, and hiking.

Recreational use in most canyons where territorial spotted owls have been recorded or that contains PACs is light because they are difficult to reach. An exception is the PAC in Scheelite Canyon, which is well-known by birders as an easily accessible site to view Mexican spotted owls. Davis and Russell (1995) and Taylor (1995), popular birding guides for southeastern Arizona, provide directions to the site, and in the case of Taylor (1995), specific information on where the birds can be found. Most birders visiting Scheelite Canyon stay on the trail, and are conscientious and unobtrusive. Viewing of spotted owls in this wooded canyon, no doubt has value in terms of environmental education and awareness.

The response of wildlife to recreational disturbance is complex, and the effects are not immediately obvious or easily determined (Hammitt and Cole 1987, Flather and Cordell 1995). Evidence suggests that recreational activity can harm wildlife (Knight and Cole 1995). Tolerance levels for wildlife interactions with humans will vary by time of year, breeding season, age, habitat type, and individual experience with recreationists (Hammitt and Cole 1987). Human activities can impact wildlife directly through exploitation and disturbance, or indirectly through habitat modification and pollution. Our concerns with regards to the canyons in which owls are present include current and future recreation use and the potential direct effects to the Mexican spotted owl of disturbance and harassment, and to a lesser extent, the indirect effects of prey habitat modification. The Recovery Plan indicates that the determining

factor of a recreational activity's impact on spotted owls is a combination of its location, intensity, frequency, and duration.

The physical characteristics of a canyon may provide topographic screening. Topographic screening between the area of disturbance and the birds location creates a noise buffer, and may assist in the reduction of noise disturbance (Knight and Cole 1995). But, the physical structure of canyons can also tend to magnify disturbances and limit escape and avoidance routes for owls (USFWS 1995b). Scheelite Canyon is a narrow, deep canyon with limited perching and roosting sites. The owls are typically perched close to the trail.

The Recovery Plan states that groups of 12 or more hikers or a steady stream of hikers occurring in narrow canyon bottoms may be especially disturbing to owls. The spotted owl breeding season, which extends from March 1 through August 31, is an especially popular time for birders and other recreationists to visit the Fort. In addition, during high use periods, large groups of hikers may use the trail, whether intentionally hiking in groups, or because groups are formed unintentionally due to hikers backed up behind each other. The potential for disturbance to Mexican spotted owls in the PAC exists given the trail location relative to past owl locations, as well as the high recreational use level on the trail during the breeding season.

There are three learned responses wildlife may show to recreationists: habituation, attraction, and avoidance (Knight and Temple 1995). Recreational disturbance during the breeding season may affect an individual's productivity; disturbance outside the breeding season may affect the individual's energy balance and, therefore, its survival. Birds may respond to disturbance during the breeding season by abandoning their nests or young, by altering their behavior such that they are less attentive to the young, which increases the risk of the young being preyed upon, or by disrupting feeding patterns, or by exposing young to adverse environmental stress (Knight and Cole 1995).

Owls have more sensitive hearing than other birds (Bowles 1995). If a noisy sound arouses an animal, it has the potential to affect its metabolic rate by making it more active. Increased activity can, in turn, deplete energetic reserves (Bowles 1995). Noisy human activity can cause raptors to expand their home ranges, but often the birds return to normal use patterns when humans are not present (Bowles 1995). Such expansions in home ranges could affect the fitness of the birds, and thus their ability to successfully reproduce and raise young. Species that are sensitive to the presence of people may be displaced permanently, which may be more detrimental to wildlife than recreation-induced habitat changes (Hammitt and Cole 1987, Gutzwiller 1995, Knight and Cole 1995). If animals are denied access to areas that are essential for reproduction and survival, then that population will decline. Likewise, if animals are disturbed while performing essential behaviors such as foraging or breeding, that population will also likely decline (Knight and Cole 1995). There is also evidence that disturbance during years of a diminished prey base can result in lost foraging time which, in turn, may cause some raptors to leave an area or not to breed at all (Knight and Cole 1995).

There are no completed studies on the effects of recreational activities specific to the Mexican spotted owl. Research on all subspecies of the spotted owl indicate that it exhibits docile behavior when approached by researchers, and there is no clear evidence of significant impact by research activity except for a negative effect on reproduction from back-pack radio transmitters (Gutierrez et al. 1995). However, researchers purposefully make as little noise as possible, and disturbance is very limited in duration. In the long term, some species may become less responsive to human disturbance if they are not deliberately harassed; others may become very stress-prone toward humans (Bowles 1995, Hammitt and Cole 1987). Excessive interaction with humans may cause a lowering of call response rates or habituation; the effects of habituation on spotted owls are unknown (Gutierrez et al. 1995). Owls have been known to begin calling during the breeding season in response to the sound of human voices (M. James, USFWS, pers. comm., 1998). Such behavior is likely characteristic of a certain percentage of individuals, and this response to humans may create a situation where these owls are discovered by hikers, thereby exposing themselves to potential direct impacts.

Ecologists suspect that spotted owls select habitats partially because of the availability of prey (USFWS 1995c). Ward and Block (1995) found that the reproductive success of the Mexican spotted owl was not influenced by a single prey species, but rather by many species in combination. Trails in riparian areas affect the soil and riparian vegetation adjacent to the trail, as well as the aquatic system itself. By directly impacting these components, recreationists affect an animal's food supply and availability as well as its habitat; in turn, impacts on food and habitat influence behavior, survival, reproduction, and distribution (Cole and Landres 1995). Impacts on soil included compaction of mineral soil, reductions in total porosity, reductions in infiltration rates, and increased soil erosion (Cole and Landres 1995). These changes in soil characteristics can adversely affect the germination, establishment, growth, and reproduction of plants. Direct impact to vegetation also comes from crushing and uprooting of vegetation. Consequently, recreation areas characteristically have vegetation that is less abundant (reduced density and cover), of a reduced stature, and with different species composition from undisturbed areas (Cole and Landres 1995). Removal of living vegetation affects the habitat and food sources of small mammals (Hammitt and Cole 1987) that comprise owl prey items. Recreationists may unintentionally start fires, for instance with discarded cigarettes, which could have a devastating effect on Mexican spotted owl habitat.

The owls in Scheelite Canyon appear to be mostly oblivious to human presence. However, there is some evidence of trampling and soil compaction off the trail and in recent years large groups of birders, apparently birding tour groups, have visited the canyon. Russell Duncan (pers. comm., 1998) reported a recent group of about 50 birders lead by a trip leader that was calling or hooting for owls in Scheelite Canyon. The Service requires a section 10(a)(1)(A) permit for use of tape-recorded calls or hooting to locate Mexican spotted owls. The Service does not issue such permits for commercial or recreational viewing of listed species. Also, as discussed, a group of 50 individuals may be a large enough presence to elicit an alarm response or to otherwise harm or harass the spotted owls in Scheelite Canyon, or disturb habitat (USFWS 1995c). In December 1992, Duncan (1993) found an adult female spotted owl in Scheelite Canyon on the ground in a lethargic state. The bird was taken to a veterinarian in Tucson where

it died after seven days. The cause of death was a pneumonia-like lung infection complicated by a subdermal hematoma probably caused by a blow to the back of the head. Duncan (1993) stated that a human-related cause of the hematoma cannot be ruled out.

The Recovery Plan notes that birders and wildlife photographers actively seek spotted owls and are therefore more disruptive than the accidental encounters associated with other recreational activities. The Plan goes on to say that hooting for spotted owls or using mousing techniques to attract owls, if practiced to excess, may disrupt an owl's territorial, mating, and nesting activities (USFWS 1995c). The Plan finds that most owls appear to be relatively undisturbed by groups of people of 12 or less. In response to Service concerns and the recommendations of the Recovery Plan, the Fort has posted a sign at the mouth of Scheelite Canyon that informs visitors that groups are limited to 12 or less; calling, hooting, or playing taped recordings to elicit responses from owls is prohibited; and that visitors should stay on the trail and be as quiet and unobtrusive as possible. This should reduce possible harassment or disruption of Mexican spotted owls in the canyon.

Rapelling or rock climbing on cliffs supporting active Mexican spotted owl nests could result in disturbance of nesting owls. Recreational rapelling and rock climbing are prohibited on Fort Huachuca; however, rapelling as part of military training occurs on cliffs in Garden Canyon. The rapelling cliff is located outside of current spotted owl PACs, and if owls are found nesting within 0.25 mile of the rapelling cliff, rapelling shall be moved at least 0.25 mile away during March 1 through August 31, or until nestlings fledge. These measures should help reduce the potential for adverse impacts to the Mexican spotted owl and its critical habitat.

Sources of noise other than those made by hikers or birders may also disturb spotted owls and include explosive ordnance discharge and delivery, discharge of firearms by hunters, small arms ammunition firing on the South Range, and aircraft overflights. Delaney et al. (1997) reviewed literature on the response of owls and other birds to noise and drew the following conclusions: 1) raptors are more susceptible to disturbance-caused nest abandonment early in the nesting season, 2) birds generally flush in response to disturbance when distances to the source are less than about 200 feet and when sound levels are in excess of 95 dBA, and 3) the tendency to flush from a nest declines with experience or habituation to the noise, although the startle response cannot be completely eliminated by habituation.

Small arms firing on the South Range could potentially disturb Mexican spotted owls. However, the firing ranges are all at least 2.4 miles from PACs (Figure 6 and 23 of BA), and any noise from such firing that reaches them is likely to attenuate well below 95 dBA. Artillery and mortar firing occurs at several areas on the East Range. Ordnance is directed eastward from these sites and is delivered into Area ZULU, also on the East Range. Noise from these sources is likely louder than the small arms firing on the South Range. However, mortar and artillery firing on the East Range occurs at a much greater distance from owl territories. All mortar and artillery firing sites and the impact zone in Area ZULU are more than 7.1 miles from the nearest PAC. No effects to spotted owls are anticipated as a result of mortar and artillery firing on the East Range.

Hunting for big game, quail, and dove is allowed within spotted owl habitat at Fort Huachuca. Potentially, a hunter could discharge a firearm near a roosting or nesting spotted owl and cause an owl to flush or elicit a startle response. However, this type of disturbance is likely to be infrequent. Most hunting occurs during the fall and winter months, outside of the spotted owl breeding season.

PACs in training area P are within the firing fan of tank gunnery range 12C that is not in use. PACs in training areas O and S fall within portions of firing ranges 12A and B and 9. Range 12B is a tank gunnery range that is not in use. Machine guns (.50 and 90mm caliber) and recoilless rifles are discharged at Range 9. At Range 12A, .50 caliber, 7.62mm, and 40mm weapons are discharged. The PACs are in the upper reaches of the firing ranges, at least 2.4 miles from firing areas. Ordnance and shells would reach PACs only if the targets were overshot. The likelihood that ordnance or shells would strike a spotted owl or nest is highly unlikely, particularly because owls are typically in wooded canyons that would be sheltered from stray weapons fire. Occasional stray fire has much greater implications for igniting fire with its associated impacts, as discussed below. However, if 12C and 12B are proposed for use during the life of the proposed action, they would be the subject of separate consultation.

Mortality or injury of Mexican spotted owls could also occur from collisions with vehicles, aircraft, power and communications lines, or as a result of electrocution on powerlines. However, reports of such mortality are rare in Arizona. The Service believes mortality or injury from collisions or electrocution could possibly occur during the life of the project, but are unlikely.

Low-level flights are sometimes authorized over the canyons of the Huachuca Mountains where Mexican spotted owls nest. Fixed wing aircraft are generally limited to elevations of 500 feet above ground level (AGL) or higher, although Arizona Game and Fish Department is granted authority to fly lower to conduct wildlife surveys. Helicopter flights may occur at elevations below 500 feet AGL. UAV flights may also occur at low levels over the Huachuca Mountains. The Fort did not supply the Service with frequency or seasonality of low-level flights; however, based on experience of Service personnel, such flights are not frequent. During extensive wildlife and plant field work at Fort Huachuca, Russell Duncan (pers. comm., 1998) has not observed low-level fixed wing or helicopter flight in montane canyons, but has observed occasional UAV flying at low levels. The Fort has proposed to continue to minimize low-level helicopter flights within one mile of active nests and would not authorize helicopter flights within 0.25 mile of an active nest.

According to a Report to Congress on Effects of Aircraft Overflights on the National Park System (U.S. National Park Service 1994), wildlife responds to low-level aircraft overflights, although the manner in which they do so depends on life-history characteristics of the species, characteristics of the aircraft, flight activities, and a variety of factors such as habitat type and previous exposure to aircraft. The primary concern stemming from these low-level overflights related to wildlife is the physiological and behavioral responses caused by the flights. These

responses may reduce the wildlife's fitness or ability to survive. Overflights may cause stress, and if chronic, stress can compromise the general health of the animal. Overflights may interfere with raising young, habitat use, and physiological energy budget. Indirect effects, such as accidental injury, energy loss, habitat avoidance, and abandonment are very difficult to detect, but some experts suspect they occur (U.S. National Park Service 1994).

Studies that have analyzed the effects of low-level aircraft overflights on birds have determined that such flights disturb raptors (Manci et al. 1988). Disturbances include interrupting nesting activities by flushing from nesting and roost, displacing birds returning to nests, flushing or displacing birds from foraging areas, provoking interactions with sympatric raptors, and exposing eggs and nestlings to predators and extreme heat. Studies have also suggested that human activity within breeding and nesting territories may affect raptors by changing home range movements (Anderson et al. 1990) and causing nest abandonment (Porter et al. 1973, Postovit and Postovit 1987). While these studies have not demonstrated a causal link between low-level overflights and reproductive success, they do document a level of disturbance that clearly is equivalent to harassment. Under section 9 of the Act, harassment is a form of take.

Compared to jets and light planes, helicopters tend to elicit a heightened response from nesting raptors (Watson 1993, Grubb and Bowerman 1997). Noise from low-level jets and sonic booms have been found to have little effect on nesting peregrine falcons and other raptor species (Ellis 1981, Ellis et al. 1991). UAVs are small and relatively quiet, and are expected to elicit less of a response than either helicopters or fixed-wing aircraft. Studies of the effects of aircraft overflights on nesting raptors often show slight, but non-significant decreases in reproductive success and number of young fledged (Platt 1977, Windsor 1977, Anderson et al. 1989, Ellis et al. 1991). Nest abandonment due to disturbance is most likely to occur early in the nesting season before birds have invested much energy in the nest and nestlings (Knight and Temple 1987). White and Sherrod (1973) found that nesting raptors flushed from nests when overflown by helicopters that approached unseen, suggesting that raptors may be more likely to flush if the noise or sight of the aircraft is sudden and in close range.

Studies of the effects of aircraft overflights on raptors have generally noted a slight but non-significant decrease in reproductive success and number of young fledged at sites exposed to overflights versus control sites without overflights (Delaney et al. 1997). Of the authorized flights over spotted owl habitat, low-level helicopter flights have the greatest potential to disturb owls (Delaney et al. 1997), because they move slowly and are relatively noisy. Delaney et al. (1999) evaluated the effects of the Sikorsky, HH-60G, and Pave Hawk helicopter over-flights on Mexican spotted owls in the Lincoln National Forest, New Mexico. Owl territories were randomly presented with one of three helicopter flight profiles, including 50 feet vertical, 100 feet vertical/100 feet lateral, and 200 feet vertical. Territories with overflights did not differ in reproductive success from territories without overflights. As the distance to the helicopter decreased, owl flush response increased. Owls did not flush in response to helicopters beyond 345 feet, and no owls flushed during the incubation and nestling phases. Flush responses occurred at a rate of 14 percent within 345 feet, 19 percent within 200 feet, and 50 percent within 100 feet. Flushing responses also did not occur when noise levels were less than 92 dBA;

however, distance to the helicopter was a better predictor of spotted owl response than sound level. Net differences in prey deliveries for the 24 hour periods after and before noise manipulations were highly correlated with stimulus distance. Delaney et al. (1999) estimated that the threshold for negative effect on prey deliveries was 315 feet. On average, an alert response (i.e., head movements) was elicited when helicopters approached within 1,330 feet, but no response was noted when helicopters were beyond 2,165 feet from an owl. Short duration, single pass aircraft flights appeared to have little effects on spotted owls; diurnal flights affected owls less than nocturnal flights; and although multiple low-level flights were not recommended, the authors believed spotted owls would habituate with repeated exposures and as the nesting season progresses (Delaney et al. 1997, 1999). Although the effects of overflights may vary with locations, specific conditions, and aircraft type, the following management implications emerged from the results of Delaney et al. (1997, 1999):

1. A 345-foot hemispherical management and protective zone should minimize, and possibly eliminate, spotted owl flush response and negative effects to prey delivery rates associated with helicopter overflights.

2. Flights over owls should be separated by at least seven days.

3. Overflights should be limited to diurnal flights if possible, and nocturnal flights, particularly within three hours of sunrise or sunset, should be minimized.

4. Helicopter flights near roosts or nests that are single pass and of short duration may be less disturbing than other flight maneuvers such as circling, hovering, or landing.

Service policy is to limit disturbing activities within 1,320 feet of nest sites during the breeding season (March 1-August 31). This corresponds well with the Delaney et al.'s (1997, 1999) 1,330-foot threshold for alert responses to helicopter flights. Encounters between low-level flights and spotted owls are expected to be infrequent. Russell Duncan (pers. comm., 1998) during extensive wildlife and plant surveys, has never observed a low-level helicopter or fixed-wing aircraft flight in the Huachuca Mountains. Low-level UAV flights are more common, but UAVs are small and relatively quiet compared to helicopters, and are expected to elicit minimal response from spotted owls. The Fort has committed to minimizing low-level helicopter flights within 1.0 mile of spotted owl nests, or the last previously known nest. Helicopter flights closer than 0.25 mile of active nests will be prohibited from March 1 to August 31. These commitments should minimize adverse effects, including the potential for take, associated with low-level aircraft flights.

Stacey and Hodgson (1995) evaluated the impacts of a 24,000-acre natural fire on Mexican spotted owls in the San Mateo Mountains, New Mexico. Birds present in four territories before the fire remained within their same territories after the fire. However, a small sample size of owls combined with an apparent low-intensity fire (the fire burned patchily, only 600 acres burned hot enough to kill all trees, and much undamaged roosting and foraging habitat remained)

makes the applicability of the study results to other owl territories or other fires questionable. Relatively few wildfires have burned in the montane portion of the Fort in recent times (Figure 13); however, fuel loads are high in some areas (Robinett et al. 1997), and several stand-replacing fires have occurred in the Huachuca Mountains to the south of the Fort in recent years. Thus, a very hot, stand-replacing fire could potentially burn in owl territories on Fort Huachuca, perhaps with much more severe impacts than those observed by Stacy and Hodgson (1995) in New Mexico.

Prescribed fire, managed natural fire, or wildfire ignited by recreationists or by ordnance strikes in the Huachuca Mountains, could result in adverse effects to owls and their habitat. Direct effects to Mexican spotted owl may include death of adults and juveniles, flushing of Mexican spotted owl off nests or roosts, smoke inhalation, and human disturbance related to fire suppression actions. Indirect effects may include loss or degradation of nesting or foraging habitat, and reduced prey densities and availability.

Patton et al. (1991) found lower survival rates among radio-tagged female northern spotted owls following a forest fire. This was attributed to radio tags, but the birds in this study were exposed to dense smoke and high levels of carbon monoxide by an inversion that trapped smoke near the ground for 25 days following a fire which burned for 50 days. Flames and smoke from fire may cause Mexican spotted owls to flush from nests or roosts, and may impair hunting opportunities through interfering with audio and visual methods of detecting prey. If fire occurs within PAC activity centers, there exists some possibility that nest or roosts trees may be killed through crowning or extreme heat. All of these may result in direct mortality, failed reproductive efforts or starvation of young and adult Mexican spotted owls.

Disturbance to the Mexican spotted owl may also be caused by human activities in, adjacent, and above PACs and potentially occupied habitat during fire suppression or management activities. Disturbance may be caused by fire resource personnel digging fire lines, walking and igniting with drip torches if "burning out" is needed to control a fire, use of chainsaws and heavy equipment, the dropping of slurry, and monitoring fire conditions from the ground or air. Human disturbance in an occupied PAC during the breeding season may result in failed reproductive efforts, abandonment of the nest, or starvation of young.

The indirect effects of fire include both negative and beneficial effects on Mexican spotted owl habitat. Beneficial aspects would include increased response of herbaceous vegetation after a fire and possible reduced future occurrence of stand-replacing fire. Negative effects would include the loss of Mexican spotted owl prey habitat components such as herbaceous cover, down logs, and snags. The effects of fire on the prey base of the Mexican spotted owl are complex and are dependent on the variations in fire characteristics and in prey habitat. Fire intensity, size, and behavior are influenced by numerous factors like vegetation type, moisture, fuel loads, weather, season, and topography. Fire can effectively alter vegetation structure and composition thereby affecting small mammal habitat. The initial effects of fire are likely to be detrimental to rodent populations as cover and plant forage species would be reduced.

Population responses by small mammals to fire-induced changes in their habitat vary. For example, deer mouse populations might increase immediately following fire and then decrease through time (Ward and Block 1995). Campbell et al. (1977) noted that populations of peromycid mice decreased immediately following fire in an Arizona ponderosa pine forest that removed one-fourth (moderately burned) to two-thirds (severely burned) of the basal area; populations then returned to pre-fire numbers two years following the bum. Furthermore, no differences were found in rodent populations between moderately and severely burned areas. They concluded that the effects of the fire that they studied were short-term, and the short-term positive numerical responses of mice were attributed to an increase in forage, particularly grasses and forbs after the fire (Ward and Block 1995). Irvine (1991) documented post-fire declines in deer mice populations at study sites on the Coconino National Forest. Irvine attributed these declines to reduced food supplies. Lowe et al. (1978) noted an increase in deer mice populations the first year after a fire in ponderosa pine near Flagstaff, Arizona. Small mammal diversity and densities are typically depressed for one to three years after a fire (Wright and Bailey 1982). Biswell et al. (1973) suggested that rodent populations would be less affected during fall fires, because at that time of year rodents have accumulated seed caches that will mitigate loss of food sources. Predation of surviving rodents that are part of the diet of the Mexican spotted owl may increase immediately after the fire. In one study in northern California, radio-collared northern spotted owls spent considerable time in burned-over areas. This activity was assumed to be due to easy capture of prey (Patton and Gordon 1995).

It is suspected that the effects of intense stand-replacing wildfires that dramatically alter forest structure and move the system to earlier seral stages would have longer-term effects on some rodent populations. Likely, early successional species such as deer mice and those that require open habitat with a well-developed herbaceous understory, such as microtine voles and pocket gophers, would benefit. In contrast, species that require a wooded or forested overstory would exhibit population declines. The net effect of such fires on the Mexican spotted owl is unclear. A fire that removes the tree canopy would likely render a portion of the area unusable for foraging by Mexican spotted owl, but if the spatial extent of crown loss is limited, a mosaic is created that could provide a diversity of prey for the owl and actually be beneficial (Ward and Block 1995). Because owl prey species evolved in ecosystems where fire was a natural process, we assume that historically, these species survived, and some even benefitted from the occurrence of fire. Fire has been excluded from most southwestern ecosystems during the 20th century, resulting in systems where fire behavior may deviate substantially from natural conditions. Effects of fire on small mammals under present environmental conditions are unclear (Ward and Block 1995).

Fire is likely to have immediate short-term adverse effects to Mexican spotted owl prey habitat. Although fire may enhance vegetative density and abundance in the long-term, short-term effects of burning, particularly in the spring and early summer when herbaceous vegetation is most critical for reproducing rodents, may limit available forage immediately after the fire. Wildfire would most likely occur in June before the onset of the monsoon. Nesting Mexican spotted owls would be most affected during this time, as they would be nesting and require a consistent supply of prey to successfully fledge young.

Prescribed and managed natural fire are extremely important management tools needed to enhance, and often to restore many ecosystem functions and processes. Reduction in habitat and various habitat-based threats have contributed to the listing of the Mexican spotted owl. The long-term benefits to the Mexican spotted owl of many land management actions may contribute, in the short-term, to certain adverse affects to the owl. Prescribed and natural fire projects often fall into this category. Species such as the owl, whose habitats have been reduced, degraded, or altered, may currently respond to fire differently than they did historically when fire occurred in a more natural setting. Therefore, it is important to address such concerns by minimizing, to the greatest extent practical, those short-term adverse effects, and move forward with proactive land management as fire is applied in efforts to restore ecosystem functions and community dynamics.

Fires have played an important role in the composition and structure of conifer forests. Historic natural fires in ponderosa pine were light, their intensity depended on fuel load and weather conditions. This created a situation whereby some areas did not burn, some areas burned intensely with crown fires, and most areas burned lightly leaving large, fire-resistant trees, killing shrub topgrowth, and removing dead fuels (Wright and Bailey 1982). In mixed conifer forests, historic fires often were composed of intense, crown-replacement in small patches. Prescribed fire may be expected to alter mixed conifer habitats of the Mexican spotted owl in the short-term to a greater extent now than historically because the fuel accumulations that are characteristic of many Mexican spotted owl nest and roost sites generally place them at higher fire risk.

Prescribed or managed natural fire are likely to create small openings in the canopy caused by single or groups of trees crowning. The risk of trees crowning is more probable in Mexican spotted owl nesting and roosting habitat. The location of quality owl habitat often corresponds to characteristics that put these sites at higher risk of crowning such as dense, multi-layered canopies, and high fuel loadings resulting from high densities of down logs. Where fire does not crown, some loss of the lower canopy is expected. This is likely to be particularly true in mixed conifer habitats which are usually denser and contain more of the "ladder fuels" created by smaller conifer trees. The loss of some of the lower branches in the canopy may have some effect on Mexican spotted owl foraging. Mexican spotted owls utilize the "perch and pounce" method of hunting, using the lower branches of trees for perching. The loss of some perching sites when burning within prescription, is not expected to significantly affect the ability of Mexican spotted owl to forage successfully.

The Recovery Plan encourages fire management programs that take an active role in fuels management and understand the ecological role of fire. The Recovery Plan also recognizes that catastrophic wildfire is one of the primary threats to the owl. Therefore, fire plays the dual role of being both potentially beneficial and catastrophic to the owl and its habitat. The Service stresses the need to apply adaptive management when using fire. Prescriptions that maintain key structural features of owl and small prey habitats should be developed and tested. These features include large trees, snags, logs, and overstory. Treatments to produce or maintain such habitat components must be assessed by monitoring to evaluate if treatment objectives were met in both

the short and long term. Wholesale use of fire without understanding or monitoring its effects on habitat may render these areas unusable by owls, and may also miss opportunities to improve our knowledge of fire effects on these habitats (Moir et al. 1995). In regard to managed natural fire in the Kachina Burn Plan, the Coconino National Forest committed to protecting 80 to 90 percent of the downed logs 12 inches diameter at breast height (dbh) and greater, and to hand-lining snags 18 inches dbh and greater for all managed natural fire actions within Mexican spotted owl protected and restricted habitat as defined by the Mexican Spotted Owl Recovery Plan (USFWS 1995c). These protective measures will assist in maintaining these important components of Mexican spotted owl prey habitat. These measures will assist in ensuring that these habitat components of importance to the Mexican spotted owl are retained in the PACs.

The Recovery Plan recognizes that managed natural fire may be beneficial to owl habitat in several ways: 1) it can aid in reducing fuel loads and the risk of catastrophic wildfire which may result in the loss of habitat over large areas; 2) it can create a diverse landscape with considerable horizontal heterogeneity which seems to be relatively characteristic of many areas occupied by spotted owls and also provides for a diverse prey base; 3) it can create conditions that maintain shade-intolerant species in the landscape.

Prescribed fire should be used carefully in owl habitat (USFWS 1995c). Fire is one of the most rapidly acting of natural disturbances. A crown fire can quickly consume vast tracts of forest. After a large crown fire, habitat components for Mexican spotted owl nesting, roosting, and foraging are reduced or eliminated. Small-scale natural fires and prescribed burns, however, can reduce fuel loads and create small openings and thinned stands that increase horizontal diversity and reduce the spread of catastrophic fire. Small-scale fires and lightning strikes also create snags, canopy gaps, and large downed logs, plus they perpetuate understory shrubs, grasses, and forbs which are important habitat components to the owl and its prey (Moir et al. 1995).

The Recovery Plan states that the nest site should be known before burning occurs in the PAC, as this information is needed to determine the location of the 100-acre activity center and protect it from fire. The most accurate, up-to-date information needs to be used to determine 100-acre activity centers before prescribed or managed natural fire is allowed to burn in PACs. Service policy is to consider PACs occupied each breeding season.

The following summarizes recommendations from the Mexican Spotted Owl Recovery Plan in regard to prescribed fire in PACs:

1. Experimentally treat (prescribed fire and fuels management) 10 percent of PACs within each recovery unit that exhibit high fire risk conditions (use of prescribed fire without mechanical treatments is not limited, except within the 100-acre nest site).

2. Treatments should retain or enhance owl habitat components.

3. Treatments should only occur during the non-breeding season (September 1 to February 28).

4. A 100-acre area around the known nest site is to be excluded from treatments.

5. Effects of treatments on the owl, prey species, and their habitats should be assessed.

If such effects are not negative, an additional sample of PACs can be treated. If negative effects are detected, measures should be developed to ameliorate those effects. If effects cannot be mitigated, no additional treatments should be permitted.

The Recovery Plan finds that catastrophic wildfire is a primary threat to the Mexican spotted owl. In some areas of the Huachuca Mountains prescribed fire or fuels treatment is necessary to avoid occurrence of a stand-replacing fire that would be highly deleterious to spotted owl habitat. Where the risk of stand-replacing fire is high in the Huachuca Mountains, the benefits of treatments to reduce that risk are likely to outweigh possible direct adverse effects of such treatments on the owl or its habitat.

The Fort has adopted the recommendations of the Recovery Plan in regard to prescribed fire, managed natural fire, and fuel treatments, with some modifications as suggested by the Service. Commitments include not burning within the 100-acre core areas, not removing trees larger than 9 in dbh in PACs, enhancement or retention of owl habitat components during treatments, limiting prescribed or managed natural fire treatments within PACs to 100 acres at a time and only outside of the breeding season, and other measures. Although fire is an imprecise tool, these measures greatly reduce the likelihood that treatments will damage spotted owl habitat or result in take. Properly applied, a fire program should provide long term protection of owl habitat from catastrophic wildfire.

Critical habitat was designated for the Mexican spotted owl on January 18, 2001 (USFWS 2001a). Included were 4.6 million acres of Federal lands in Arizona, Colorado, New Mexico, and Utah. A total of 830,000 acres were designated in Arizona of which 24,038 acres occur on Fort Huachuca. Critical habitat designated includes areas within the mapped boundaries that meet the definition of protected and restricted areas. Protected areas are areas where owls are known to occur or are likely to occur. Protected areas include: (1) 600 acres around known owl sites within mixed conifer forests; or (2) pine-oak forests with slopes greater than 40% and where timber harvest has not occurred in the past 20 years. Restricted habitat includes areas outside of protected areas which may contain Mexican spotted owls. Restricted areas include mixed conifer forest, pine-oak forest and riparian areas.

Some activities at Fort Huachuca have the potential to adversely affect critical habitat. These activities include recreational and aviation activities, wildfire ignited by authorized ordnance use or recreation, prescribed fire, and fire suppression. The most important of these are wildfire and

prescribed fire, and fire suppression activities. Wildfire ignited by recreational users or ordnance, prescribed fire, and fire suppression activities could result in direct effects to owl critical habitat in the forested area on the installation, or perhaps on nearby Forest Service lands. Indirect effects could also occur from these activities, particularly as a result of watershed degradation and subsequent erosion and sedimentation. Effects from recreational use, to include the cumulative effects of an increasing population in the region, also have the potential to affect owl critical habitat.

Fort Huachuca has committed to conservation measures as part of the proposed action that would reduce or eliminate most potential adverse impacts to the Mexican spotted owl and its critical habitat. Some of these conservation measures include wildfire suppression and prevention measures, prescribed fire and fuels management to reduce fuel loads and the chance of catastrophic fire, minimal military training in the Huachuca Mountains, limiting aircraft flights below 500 feet AGL and helicopter flights near PACs and nest sites, and limitations on recreational activities in canyons where Mexican spotted owls occur.

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (state, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions would be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed action. Effects of past Federal and private actions are considered in the Environmental Baseline. Because of the extent of Federal lands in the area (Coronado National Forest, Fort Huachuca, Coronado National Memorial, and BLM), many activities will involve Federal agencies, and thus are not considered cumulative effects. In particular, potential nesting habitat of the Mexican spotted owl in the project area is in the montane canyons of the Huachuca Mountains. These canyons are, for the most part, managed by Federal agencies. Exceptions include the Peterson Ranch in Scotia Canyon, lower Ramsey Canyon, and other small parcels, mostly in the lower reaches of the canyons. Most of these sites are too low in elevation to support nesting spotted owls, although the species may use these areas when not nesting. Owls have been recorded nesting near the Peterson Ranch property, but it may be acquired by the Coronado National Forest through a land exchange.

Population growth in the Sierra Vista area and the popularity of the area as a recreational destination is resulting in increased use of Mexican spotted owl habitat in the Huachuca Mountains. In addition, private lands at the mouths of many canyons to the south of Fort Huachuca are being developed as housing tracts or ranchettes. The lower reaches of these canyons may provide wintering spotted owl habitat. This increasing human presence is likely to result in increased disturbance of any Mexican spotted owls in the area.

Effectiveness of Proposed Conservation Measures

The Fort has proposed many important conservation measures as part of the proposed action that would reduce or eliminate most potential adverse effects to the species and its habitat resulting

from the proposed action. Some of the conservation measures that are expected to benefit the Mexican spotted owl can be summarized as follows:

1. Fort Huachuca will conduct annual monitoring of all known PAC's and surveys of potential Mexican spotted owl habitat at Fort Huachuca following Service survey protocol.

2. The Fort will complete the endangered species management plan for the Mexican spotted owl that conforms to and complements the Mexican spotted owl Recovery Plan by July 2003.

3. General fire coordination will be accomplished as specified in Section 5.4.7 of the BA. Also, the following measures will be implemented:

a. Areas within PACs treated to reduce occurrence of wildfire, prescribed fire or fuels management will be monitored, as described in the Recovery Plan, to determine effects of the treatment on known owl habitat components. If adverse effects are detected, treatments will be modified to reduce those effects as much as possible while still reducing the risk of wildfire.

b. One of the objectives of fire suppression activities in the Huachuca Mountains will be protection of Mexican spotted owl PACs. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

c. If a Mexican spotted owl is encountered during fire activities, the Resource Advisor will be notified immediately. The Resource Advisor will assess potential harm to the owl and advise the fire boss of methods to prevent harm. The Resource Advisor will maintain a record of any Mexican spotted owls encountered during suppression activities. The information will include for each owl the location, date, and time of observation and the general condition of the owl, and response to the fire and fire activities.

d. All fire suppression actions in PACs will occur, to the maximum extent possible, using "light on the land" methods, including not removing trees over 9 inches dbh unless it is deemed necessary by the fire boss to prevent the fire from effecting additional PAC acres, or to protect life or property.

e. Patches of unburned vegetation within burned areas in the Huachuca Mountains will not be burned out as a fire suppression measure, except as needed to secure the fire perimeter or provide for fire fighter safety.

f. The Fort, in coordination with the Service, will develop a mitigation and monitoring plan for each prescribed fire, managed natural fire, or fuels treatment that may adversely affect the Mexican spotted owl. Prescribed fire and fuels treatment will be designed to protect Mexican spotted owls and their habitat.

g. Treatments and prescribed fire will not occur within a 100-acre area around spotted owl nest sites. This 100-acre area will include habitat that resembles the structural and floristic characteristics of the nest site. The 100-acre area will be protected by using topographic and other barriers, or through line construction. All line construction in PACs will occur outside the Mexican spotted owl breeding season, will not remove any trees larger than 9 inches dbh unless they pose a threat to the safety of fire fighters, and will only occur with a resource advisor on-site.

h. Treatments will enhance or retain owl habitat components, such as downed large logs greater than 12 inches in midpoint diameter, hardwoods, grasses, forbs, and shrubs, while still reducing the chance of wildfire. In regard to downed logs, this will be achieved by protecting 80 to 90 percent of the downed logs 12 inches diameter or larger, and hand-lining snags 18 inches dbh or larger for all managed natural fire actions within PACs.

i. Treatments will produce a mosaic of habitat components within PACs.

j. Prescribed or managed natural fire will be introduced in PACs in blocks of 100-acres or less, and only between September 1 and February 28, outside the Mexican spotted owl breeding season.

k. Prescribed or managed natural fire will be introduced into potential Mexican spotted owl nest/roost habitat only if at least two years of surveys, in accordance with Service protocol have been conducted, and for which one year of follow-up survey (four visits) has been conducted, if more than one breeding season has elapsed since the last survey to protocol and the action. Furthermore, introduction of fire into PACs will only occur if the nest/roost site is known the year of the action, or for which nest/roost site information is less than three years old. If nest/roost information for a PAC is three years old or more, a 200-acre nest buffer will be deferred from treatment until such a time, as the nest/roost can be located again.

l. All prescribed or managed natural fire will be suppressed if it is anticipated that the fire may burn out of prescription in the next 24 hours. The Fort may choose to suppress actions before this.

m. For prescribed or managed natural fire, the Fort will ensure that no more than 10 percent of the canopy of each PAC will be affected by gaps created by single or groups of trees crowning. Groups of trees that "crown out" will not exceed two acres in size.

n. The Fort will ensure that no more than two PACs per year on Fort Huachuca are affected by prescribed or managed natural fire. A PAC is considered affected if one or more acres of the PAC are burned to any degree. If prescribed or managed natural fires in one year are located in PAC(s) outside of the nest buffer, and are 1 to 10 acres, the Fort will discuss with the Service the option of allowing prescribed or managed natural fire to occur in one additional (or the same) PAC.

o. The effects of prescribed fire, managed natural fire, and fuels treatment on the owl and its habitat will be monitored. Such monitoring will include quantifying acres of 100-acre activity centers, PACs, and potential habitat affected by these activities.

p. The Service will approve mitigation and monitoring plans in writing. Such plans will be developed before implementation of prescribed fire. Mitigation and monitoring for managed natural fire that may adversely affect the Mexican spotted owl will be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

q. Areas of significant human activity during fire suppression operations, prescribed fire, or managed natural fire in the Huachuca Mountains such as fire crew camps, landing strips, and equipment staging areas, will be located outside of PACs. Areas disturbed during fire suppression activities in the Huachuca Mountains such as fire lines, crew camps, and staging areas will be rehabilitated; including the obliteration of fire lines to prevent their use by vehicles or hikers.

4. The Fort will minimize low-level helicopter flights within 1.0 mile of the nest, or the site of the last previously known nest in canyons containing active spotted owl nests, or in canyons where occupancy or reproductive status is unknown,. Helicopter flights closer than 0.25 mile to active nests will be prohibited from March 1 to August 31.

5. If Mexican spotted owls are found nesting in Garden Canyon within 0.25 mile of the rappelling cliffs, rappelling will be halted or moved at least 0.25 mile from the active nest from March 1 through August 31, or until nestlings fledge.

6. The Fort will maintain the permanent all-weather sign near the Scheelite Canyon trailhead (not visible from Garden Canyon Road) that informs visitors of the following:

a. The Canyon is home to sensitive species.

b. Visitors should stay on the trail and be as quiet and unobtrusive as possible.

c. Groups of visitors are limited to 12 or less.

d. Calling, hooting, or playing of taped recordings to elicit responses from or to locate owls is prohibited in Scheelite Canyon without special permit from the US Fish and Wildlife Service.

e. Smoking is prohibited.

7. All maintenance activities in Garden Canyon will occur within the existing roadbed or catch basins and will only occur during the day. Silt fencing will be used where there is the potential for sediment to enter Garden Canyon Creek. No vegetation will be removed outside of the existing roadbed and no invasive plant or animal species will be introduced. No water will be used from Garden Canyon Creek. Contractors will be trained to recognize Mexican spotted owls and instructed to follow these conservation measures.

8. The Fort will monitor take of Mexican spotted owls and document any disturbance of owls or owl habitat. This and other monitoring required here will be reported to the Service pursuant to the reporting requirements described below.

Conclusion

After reviewing the current status of the Mexican spotted owl, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Mexican spotted owl. Critical habitat is designated for this species within the action area, but none will be adversely modified or destroyed. Our conclusion is based on the following:

1. Mexican spotted owls at Fort Huachuca occur primarily in remote canyons of the Huachuca Mountains that few recreationists visit (an exception being Scheelite Canyon) and where little or no military training occurs;

2. Few military overflights occur in the canyons of the Huachuca Mountains where spotted owls are located, and most flights occur above 500 feet AGL;

3. Recreational rock climbing and rapelling are prohibited at Fort Huachuca. Rapelling as part of military training is restricted to a cliff in Garden Canyon, which is outside of known owl PACs.

4. The threat of wildfire is being addressed by the Fort through a comprehensive fire management plan that calls for prescribed fire and reduction of fuel loads. Implementation of the plan will help reduce the chance of catastrophic stand-replacing fire that could adversely affect owl nesting and foraging habitat;

5. The proposed action affects a relatively small part of the range of this threatened species;

6. The Fort proposes substantial conservation measures that reduce the effects of the proposed action on the Mexican spotted owl.

Incidental Take Statement

Section 9 of the Act and Federal regulation following section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Fort Huachuca so that they become binding conditions of any grant or permit issued to any applicant, permittee, or contractor, as appropriate, for the exemption in section 7(o)(2) to apply. The Fort has a continuing duty to regulate the activity covered by this incidental take statement. If the Fort (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant, permittee, or contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, Fort Huachuca must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(I)(3)].

Amount or Extent of Take

Take may be in the form of harm, harassment, injury, or death resulting from the loss of a nesting site, loss or disturbance of a nest by recreational or military activities, loss or degradation

of foraging habitat as a result of fire, and collision of a Mexican spotted owl with a vehicle, antennae, fences, or other project features. The Service anticipates incidental take of Mexican spotted owl will be difficult to detect or determine. The Fort's proposed conservation measures greatly reduce the chance that take would occur; however, we anticipate the take, through direct injury or mortality, or harm of a total of two Mexican spotted owls, or one nest with eggs or nestlings as a result of the above causes over the life of the project at Fort Huachuca. Additionally, take of one Mexican spotted owl is anticipated in the Scheelite Canyon PAC and one Mexican spotted owl elsewhere at Fort Huachuca over the life of the project as a result of harassment due primarily to recreational activities, but also possibly as a result of other causes listed above.

This biological opinion does not authorize any form of take not incidental to implementation of the proposed action as described in this opinion and in ENRD (2002).

Effect of the Take

The Service has determined that the level of anticipated take is not likely to jeopardize the continued existence of the Mexican spotted owl nor destroy or adversely modify designated critical habitat.

The Service will not refer the incidental take of Mexican spotted owl for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§703-712), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

Reasonable and Prudent Measures

The Service believes that no reasonable and prudent measures are necessary, because the conservation measures proposed by Fort Huachuca include all possible measures to minimize impacts of incidental take of the Mexican spotted owl. Therefore, because there are no reasonable and prudent measures, there are no terms and conditions.

If the incidental take anticipated in the paragraph entitled "Amount or Extent of Take is met, the Fort shall immediately notify the Service in writing. If, during the course of the action, the level of anticipated incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation. In the interim, the Fort must cease the activity resulting in the take if it is determined that the impact of additional taking will cause an irreversible and adverse impact on the species. Fort Huachuca must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendation provided here does not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the Mexican spotted owl. In furtherance of the purposes of the Act, we recommend consideration of the following action:

1. The Fort could study the effects of recreational activity on Mexican spotted owls and their habitat in Scheelite Canyon. The study should quantify recreational use, effects on owl behavior, energetics, movements, and reproduction, as well as effects to the habitat resulting from trampling, potential for fire, etc.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitat, the Service requests notification of the implementation of any conservation recommendations.

SONORA TIGER SALAMANDER (*Ambystoma tigrinum stebbensi*)

Status of the Species

The Sonora tiger salamander is a large salamander with a dark venter and light-colored blotches, bars, or reticulation on a dark background. Snout-vent lengths of metamorphosed terrestrial salamanders vary from about 2.6 to 4.9 inches (Lowe 1954, Jones et al. 1988). Larval salamanders are aquatic with plume-like gills and well-developed tail fins (Behler and King 1980). Larvae hatched in the spring are large enough to metamorphose into terrestrial salamanders from late July to early September, but only an estimated 17 to 40 percent metamorphose annually. Remaining larvae mature into branchiates (aquatic and larval-like, but sexually mature salamanders that remain in the breeding pond) or over-winter as larvae (Collins and Jones 1987; James Collins, Arizona State University, pers. comm., 1993). The Sonora tiger salamander was listed as endangered on January 6, 1997 (USFWS 1997a). No critical habitat has been proposed or designated. A recovery plan has been drafted (USFWS 1999c).

This subspecies was described by Lowe in 1954, subsequent field surveys, and genetic analysis in the 1980's and 1990's reinforced the status of the Sonora tiger salamander as a distinct subspecies (USFWS 1999c). It is one of three subspecies found in Arizona. The other two are Arizona tiger salamander (*A. t. nebulosum*) and barred tiger salamander (*A. t. mavortium*).

The Sonora tiger salamander is known from about 53 breeding localities (Collins and Jones 1987, Collins 1996, USFWS 1997a, Abbate 1998, Ziemba et al. 1998, Jon Snyder, Arizona State University, pers. comm., 1999; Mike Pruss, Arizona Game and Fish Department, pers. comm. 1999); although at any one time not all of these sites are occupied. During intensive surveys in 1997, from one to 150 Sonora tiger salamanders were found at 25 stock tanks (Abbate 1998). Populations and habitats are dynamic, thus the number and location of extant aquatic populations changes over time, as exhibited by the differences between survey results in 1985 and 1993 to 1997 (Collins and Jones 1987, Collins 1996, James Collins, pers. comm., 1996, Abbatte 1998, Ziemba et al. 1998). Some sites that once supported salamanders are now inhabited by nonnative predators that preclude recolonization.

In Arizona, currently known populations are located in San Rafael Valley, Harshaw and Cooper Canyons, Coronado Memorial, and on Fort Huachuca. Salamanders suspected of being Sonora tiger salamanders were found in the Los Fresnos cienega in Mexico (USFWS 1999c).

Salamanders that may be Sonora tiger salamanders have also been found at the lower Peterson Ranch tank in Scotia Canyon, Upper Garden Canyon Pond at Fort Huachuca, and at Los Fresnos in the San Rafael Valley, Sonora. Salamanders have not been found at the Scotia Canyon site for several years; this population may be extirpated. Additional reports of the salamander from one mine, one cave, and one spring-fed well have yet to be confirmed (Ziemba et al. 1998). All sites where Sonora tiger salamanders have been confirmed are located in the San Rafael Valley and adjacent portions of the Patagonia and Huachuca Mountains in Santa Cruz and Cochise Counties, Arizona. All confirmed historical and extant aquatic populations are found in cattle tanks or impounded cienegas.

Historically, the Sonora tiger salamander probably inhabited springs, cienegas, and possibly backwater pools that were extant long enough to support breeding and metamorphosis (at least two months), but ideally were permanent or nearly permanent, allowing survival of mature branchiates. The grassland community of the San Rafael Valley and adjacent montane slopes, where all extant populations of Sonora tiger salamander occur, may represent a relict grassland and a refugium for grassland species. Tiger salamanders in this area became isolated and, over time, genetically distinct from ancestral *A. t. mavortium* and *A. t. nebulosum* (Jones et al. 1995). Contrary to the statement in SAIC (1998a) that "these salamanders in Arizona were introduced into stock tanks by humans, genetic work by Jones et al. (1995) suggests the subspecies known as the Sonora tiger salamander originated in the San Rafael Valley, and was not introduced by humans. This subspecies has opportunistically taken advantage of available stock tank habitats as natural habitats disappeared (Hendrickson and Minckley 1984) or were invaded by nonindigenous predators with which the salamander cannot coexist (USFWS 1997a).

Primary threats to the salamander include predation by nonindigenous fish and bullfrogs, a disease, catastrophic floods and drought, illegal collecting, introduction of other subspecies of salamanders that could genetically swamp *A. t. stebbinsi* populations, and stochastic extirpations or extinction characteristic of small populations with low genetic variability. Predation by catfish (*Ictalurus* spp.), bass (*Micropterus* spp.), mosquitofish (*Gambusia* spp.), and sunfish (*Lepomis* spp.) can eliminate stock tank populations of Sonora tiger salamander (J. Snyder, pers. comm., 1996; Collins et al. 1988). The salamanders can apparently coexist with bullfrogs, but bullfrogs prey on salamanders (J. Snyder, pers. comm., 1996) and perhaps if they are present in sufficient densities could reduce or eliminate salamander populations. Tadpoles of wood frogs (*Rana sylvatica*) are known to feed on spotted salamander (*Ambystoma maculatum*) eggs (Petranka et al. 1998), but under experimental conditions bullfrog tadpoles do not feed on viable salamander eggs or hatchlings (Collins 1996, J. Collins, pers. comm., 1996). A disease, recently identified as an iridovirus, has been documented at numerous tanks in the San Rafael Valley (Jancovich et al. 1998). Once introduced to a stock tank, most or all aquatic salamanders die (Collins et al. 1988, Jancovich et al. 1998). The disease may be spread by birds, cattle, or other animals that move among tanks (Jancovich et al. 1998). The disease could also be spread by researchers if equipment such as waders and nets used at a salamander tank are not disinfected or allowed to thoroughly dry before use at another tank. Diseased salamanders were found at two tanks in 1997 (Abbate 1998).

Ambystoma tigrinum mavortium or *stebbinsi* X *mavortium* crosses have been confirmed for the first time at two stock tanks in the San Rafael Valley (Ziemba et al. 1998). Genetic swamping of *stebbinsi* populations may already be underway. Cattle grazing occurs throughout the range of the Sonora tiger salamander, with the exception of Bog Hole in the San Rafael Valley and a site on Fort Huachuca. Cattle can trample salamanders and their eggs, and degrade habitat at stock tank breeding sites. Overgrazing can cause loss of cover and erosion that can threaten the integrity of stock tanks used by the salamander. Genetic analysis suggests very little genetic variability in Sonora tiger salamanders (Jones et al. 1988, Jones et al. 1995, Ziemba et al. 1998). In populations with low genetic variability lethal alleles are more likely to be expressed, disease resistence may be low, and evolution and adaptation to a changing environment is relatively slow.

For further information on the ecology, taxonomy, range, and threats to this subspecies, refer to Collins (1981, 1996), Collins and Jones (1987), Collins et al. (1988), Gelhbach (1967), Jancovich et al. (1998), Jones et al. (1988, 1995), Lowe (1954), Snyder et al. (1996, 1998), and Ziemba et al. 1998.

Environmental Baseline

On Fort Huachuca, tiger salamanders are known from Upper Garden Canyon Pond near the crest of the Huachuca Mountains and the junction of Sawmill and Garden Canyons, and also from the wastewater treatment ponds and the golf course. In 1998, salamanders were collected from the Upper Garden Canyon Pond and from the wastewater treatment ponds. Mitochondrial DNA sequencing and allozyme analysis of salamanders from the wastewater treatment ponds suggests that these salamanders are *Ambystoma tigrinum mavortium*. Analysis of salamanders from upper Garden Canyon pond was less clear. These animals showed a high level of heterozygosity, which is uncharacteristic of *A. t. stebbinsi*, but the mitochondrial DNA sequencing suggested these animals are identical to the majority of *stebbinsi* populations in the San Rafael Valley. A cannibalistic morph was also found at upper Garden Canyon pond, which is highly unusual for *stebbinsi* populations, but a common occurrence in populations of *A. t. mavortium*. These salamanders could be hybrids between the two subspecies, but available data are inadequate to make this determination (Storfer et al. 1999.) Additional genetic work, using microsatellite DNA analysis, is underway to clarify the taxonomy of this population. This biological opinion is based on the assumption that salamanders at Upper Garden Canyon Pond are Sonora tiger salamanders and that other populations east of the Huachuca Mountains on Fort Huachuca are *A. t. mavortium*. If this is not the case, the findings herein, including our conclusion, reasonable and prudent measures, and terms and conditions will need to be reassessed.

Three populations of Sonora tiger salamanders are known to exist in the Huachuca Mountains. These salamanders occur in Scotia and Copper Canyons off-post, and in Upper Garden Canyon on post. Tiger salamanders suspected of being Sonora tiger salamanders occurred in recent years at the lower Peterson Ranch tank in Scotia Canyon, which is within one mile of Gate No. 7 and Upper Garden Canyon Pond. The upper reaches of Scotia Canyon supports perennial surface water and the canyon may be a movement corridor for salamanders to access higher elevation sites in the Huachuca Mountains from localities in and near the lower reaches of Scotia and Sunnyside Canyons. Salamanders have not been observed at the lower Peterson Ranch tank in the last few years; this population may be extirpated.

Threats to Sonora tiger salamander in the project area include erosion, sedimentation, and smoke or ash toxicity due to wildfire, prescribed fire, or managed natural fire, and suppression activities; death or injury of salamanders due to off-road vehicles illegally driving through Upper Garden Canyon Pond; illegal collection of salamanders for bait or other purposes; introduction of nonindigenous fish, bullfrogs, or other subspecies of salamanders to Sonora tiger salamander habitat that may prey upon or spread disease to Sonora tiger salamanders; and in the case of

other subspecies, interbreed with and cause genetic swamping of Sonora tiger salamander populations. Crayfish are present in Upper Garden Canyon Pond and likely prey on salamander larvae and eggs, but such predation has not been documented.

The Upper Garden Canyon Pond nearly went dry in the spring of 1996, at which time only one aquatic salamander was apparently present (SAIC 1998a). The pond dried again in June 1997 (J. Collins, pers. comm., 1998) and June 1999 (J. Rorabaugh, USFWS, pers. comm. 1999). Periodic drying results in the elimination or metamorphosis of aquatic larval and branchiate salamanders. Reduced water levels stimulates metamorphosis, and many salamanders simply walk away from drying ponds and return to breed when the pond refills. However, if the pond remained dry for several seasons or for years, or water was not present long enough to allow breeding and metamorphosis, the number of surviving terrestrial salamanders might not be sufficient to recolonize the pond. Recolonization would then have to occur as a result of immigration from another pond. If the population at lower Peterson Ranch tank is extirpated, no known salamander populations are nearby (closer than three or four miles) from which immigrants could be expected. Thus, once extirpated from the Upper Garden Canyon Pond, natural recolonization might not occur, or might take a very long time. Previous vehicle travel through Gate No. 7 and into Scotia Canyon has caused localized areas of erosion in the upper parts of Scotia Canyon that may have contributed to a head cut that threatens to breach the lower Peterson Ranch tank. However, the Fort recently closed gate No. 7, removed the cattle guard, and placed boulders and fencing at the gate to prevent vehicular travel between Garden and Scotia Canyons.

Effects of the Proposed Action

The only direct or indirect effects of the proposed action that have much potential to adversely affect the Sonora tiger salamander are effects of wildfire ignited by authorized activities, such as ordnance, careless recreationists, catalytic converters, and other human-caused sources; prescribed fire and managed natural fire; and fire suppression activities.

We are not aware of any studies that evaluated the effects of fire on salamanders. However, fire could potentially result in direct death or injury of salamanders, and reduced habitat quality or quantity. Degradation of watershed condition immediately after fires results in dramatically increased runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). In degraded watersheds, less precipitation is captured and stored, thus perennial aquatic systems downstream may become ephemeral during dry seasons or drought (Rinne and Neary 1996). Fire, whether ignited by a natural or human-caused source, could result in degradation of the immediate watershed around a pond, and result in erosion, sedimentation, and ash flow into the pond. Although effects on salamanders are unknown, in salmonid fish, ash and slurry flow into streams can be toxic and populations of macroinvertebrates (salamander prey species) can be drastically reduced after a fire (Rinne and Neary 1996), at least temporarily (Roby and Azuma 1995). Smoke diffusion into water and ash flow can result in high levels of phosphorus and nitrogen (Spencer and Hauer 1991) with unknown effects to salamanders. James Petranka (University of North Carolina at

Ashville, pers. comm.,1998) notes that fire can be detrimental to plethodontid salamanders by eliminating ground cover and associated invertebrates that are key food sources. Mike Lanoo (Indiana University School of Medicine, Muncie, pers. comm.,1998) has never observed any direct effect to tiger salamanders as a result of summer fires in Indiana prairies, but he has noted reduced invertebrate populations in high sediment habitats that resulted in lower food availability for salamanders. In this case, a red-leg (a bacterial infection) outbreak occurred. Dr. Lanoo suspected that ash flow into a pond could cause the same result.

Siltation of a pond from erosion and runoff following a fire could eliminate habitat. However, the effects of siltation may also be more subtle. Lefcort et al. (1997) examined the effects of silt on growth and metamorphosis of larval mole salamanders (*Ambystoma opaceum* and *A. tigrinum tigrinum*). Salamanders in silty water grew more slowly, metamorphosed sooner, and were more susceptible to infection by a water mold (*Saprolegnia parasitica*) than salamanders in non-silty water.

Fire effects could occur on or off of Fort Huachuca. A wildfire or prescribed or managed natural fire that escapes prescription could potentially burn onto Coronado National Forest land west of the Fort and affect salamander populations and habitat on the west slope of the Huachuca Mountains and adjacent areas of the San Rafael Valley. The chance of a large regional fire resulting from an ignition at Fort Huachuca during the life of the project is probably low, but high fuel loads in portions of the Huachuca Mountains on post (Danzer et al. 1997) and recent large stand-replacing fires in the Huachuca Mountains to the south of Fort Huachuca (Carr Peak fire in 1977, Pat Scott Peak fire in 1983, Oversight and Merritt fires in 2002) suggest that such a fire is possible. General Wildlife Services (1999) suggest that the Garden Canyon area "is perhaps primed for a catastrophic fire that could lead to major erosion and debris flow on the mid-elevations of the watershed and possible flooding and channel scouring in the lower drainage. The Fort has committed to implementing prescribed fire and fuels management as soon as possible to reduce the fire risk.

Upper Garden Canyon Pond is the most important habitat for the salamander at Fort Huachuca, because breeding and larval development occurs there. Little is known about where adult terrestrial Sonora tiger salamanders go when not at the breeding ponds. Unlike some salamanders, terrestrial Sonora tiger salamanders are virtually never encountered on the surface, except at or in the immediate vicinity of breeding ponds. However, a Sonora tiger salamander was captured in a pit fall trap at Oak Spring in Copper Canyon, Huachuca Mountains, by Arizona Game and Fish Department personnel. The nearest known breeding site is about 0.6 mile to the south, suggesting the salamander may have moved at least that far. The capture in a pit fall trap also confirms that the individual was surface active. In other subspecies of *Ambystoma tigrinum*, metamorphs may disperse hundreds of meters from the breeding pond, or may remain nearby (Gelbach et al. 1969, Petranka 1998). Of hundreds of marked *Ambystoma tigrinum nebulosum,* two were found to move from 0.9 to 1.2 miles to new ponds (J. Collins, pers. comm., 1998). On Fort Huachuca, Sheridan Stone (pers. comm., 1998) reports finding terrestrial tiger salamanders (probably *A. t. mavortium*) 1.9 to 2.5 miles from the nearest known breeding pond. Referring to conservation of the California tiger salamander, *A. californiense*,

Petranka (1998) finds that based on studies of movements of other *Ambystoma* species, conservation of a 650 to 1,650-foot radius of natural vegetation around a breeding pond would protect the habitat of most of the adult terrestrial population.

Adults of western subspecies of *A. tigrinum* typically live in or about mammal burrows (Petranka 1998), although metamorphs may construct their own burrows, as well (Gruberg and Stirling 1972, Semlitsch 1983). Some species of salamanders exhibit seasonal migrations of up to several miles each way from breeding sites to upland habitats (Stebbins and Cohen 1995). If such migrations occur in the Sonora tiger salamander, we have no information about migration corridors or non-breeding habitat. Because of the arid nature of the environments in this region, if salamanders move very far from breeding ponds, they may use wet canyon bottoms, such as Scotia and Garden Canyons, as movement corridors.

Probably the greatest threat to non-breeding terrestrial salamanders is fire. Erosion and increased runoff could bury or flood burrows, burrow entrances, rock shelters, or other cover sites. Fire may also reduce surface cover such as logs and debris, resulting in reduced invertebrate populations and reduced prey densities for salamanders (James Petranka, pers. comm., 1998). Reduced cover may also result in heating and dessication of moist cover sites that salamanders require.

Fire suppression activities could also affect salamanders or their habitat. Most important, during fire suppression helicopters are sometimes used to scoop water from ponds or lakes and then drop that water on the fire. Ponds that are depleted from such operations are often refilled from a nearby large lake or reservoir. Because of the location of Upper Garden Canyon Pond at Fort Huachuca and its small size, it is unlikely that a helicopter would attempt to take water from it for fire suppression. However, if that occured, aquatic salamanders could be scooped out of the pond and dropped on the fire. If the pond was refilled from Parker Canyon Lake or one of the impoundments on the Fort, nonindigenous predaceous fish, bullfrog tadpoles, or *Ambystoma tigrinum mavortium* could be introduced into the pond with deleterious effects described above in the Status of the Species. Introduction of *A. t. mavortium* into the range of *A. t. stebbinsi* could be particularly damaging, and once introduced it could spread to other ponds. If fish were introduced into the Upper Garden Canyon Pond, they likely would not survive for long, because the pond dries periodically.

Collection, transport, or release of salamanders or live fish, and driving off-road through ponds is illegal at Fort Huachuca. However, an employee of the Fort recently admitted to collecting and selling tiger salamanders (probably *Ambystoma tigrinum mavortium*) from ponds on the bajada at Fort Huachuca east of the Huachuca Mountains (Jon Snyder, pers. comm., 1998). Effects of collection, sale, and use of salamanders by anglers, and effects of other such illegal activities are considered interrelated and interdependent to the Fort's activities. Driving through Upper Garden Canyon Pond and introduction or collection of salamanders and other organisms by the public or employees could not occur but for jobs provided by the Fort, and public access authorized by the Fort and provided for by roads maintained by the Fort. The Fort placed

barriers around the pond to prevent vehicles from accessing the pond. The pond is signed as closed to off-road vehicle use, fishing, and capture or release of salamanders.

There are 16 ponds (about 32 acres) located on post. Seven of these ponds are stocked with trout if water conditions are favorable (Figure 5), and some ponds are known to contain bass, sunfish, or catfish. Most fishing occurs at Golf Course, Gravel Pit, Lakeside, and Woodcutter's ponds (J. Hessil, pers. comm., 1998). In Arizona, anglers commonly move fish among aquatic sites, either to create new fishing opportunities, or by use of bait fish (USFWS 1999d, 2002). As discussed, introduction of sunfish, bass, mosquitofish, or catfish or other nonindigenous fish could result in elimination of aquatic salamanders from Upper Garden Canyon Pond.

Tiger salamanders are commonly moved among sites by anglers and bait collectors. Illegal transport and introductions of salamanders in the San Rafael Valley were documented by Collins and Jones (1987), and as noted above, illegal collection and sale of salamanders has occurred at Fort Huachuca. Salamanders could be collected from Upper Garden Canyon Pond by bait collectors. The relatively clear water in the pond facilitates detection and collection. If salamanders were transported to the Upper Garden Canyon Pond from ponds elsewhere at Fort Huachuca or from other locales east of the Huachuca Mountains, these salamanders would likely be *Ambystoma tigrinum mavortium*; which could genetically swamp *A. t. stebbinsi* at Upper Garden Canyon Pond and could potentially move down Scotia Canyon to other salamander localities. Transport of salamanders among ponds could also spread the iridovirus that regularly decimates populations in the San Rafael Valley. Sheridan Stone (pers. comm., 1998) recorded a die off of tiger salamanders at one of the ponds at the Fort's wastewater treatment ponds. The iridovirus is a likely cause. The disease could also be spread by anglers via waders, tackle, or other equipment used at a pond where the disease is present and then using that same wet or muddy equipment at Upper Garden Canyon Pond.

The following factors suggest that the likelihood of collection of salamanders, intentional or unintentional stocking of fish or salamanders at Upper Garden Canyon Pond, and the spread of disease to the pond by anglers, is probably low during the life of the project: 1) transport and release of live salamanders and fish is illegal at Fort Huachuca, thus these activities probably occur infrequently, 2) fisherman are required to obtain a Fort Huachuca fishing permit and permitted individuals are given a fact sheet that clearly states live fish may not be transported or used as bait on Fort Huachuca, and 3) the Upper Garden Canyon Pond is far removed from stocked ponds and tanks, which are on the bajada. If fish were illegally introduced to Upper Garden Canyon Pond, periodic drying of the pond would eliminate them, but perhaps not before the fish had eliminated the aquatic salamanders.

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (state, local government, and private) actions that are reasonably certain to occur in the project area. Future Federal actions would be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed project. Effects of past Federal and

private actions are considered in the Environmental Baseline. Much of the land in the project area is managed by Federal agencies, particularly the Coronado National Forest, Fort Huachuca, and Coronado National Memorial. However, several of the known occupied breeding localities are located on private lands to the west of Fort Huachuca, and others are likely to occur on private lands because only the Federal lands have been surveyed extensively. These private lands are used primarily for grazing, but potentially could be subdivided and developed as ranchettes, or used for other purposes. Compliance with the Act for activities on private lands that may affect the Sonora tiger salamander, but are not addressed by section 7 consultation, could occur through section 10(a)(1)(B) of the Act.

Effectiveness of Proposed Conservation Measures

The Fort has proposed substantial measures that would reduce or eliminate most potential adverse effects of the proposed action on the salamander and its habitat. Proposed conservation measures for the Sonoran tiger Salamander are incorporated as part of the proposed action, and are summarized below.

1. Fort Huachuca shall conduct annual monitoring of the upper Garden Canyon pond in June or early July (pre-monsoon) of each year to determine condition of the habitat and presence of aquatic salamanders according to protocol approved by the Service.

2. General fire coordination shall be accomplished as specified in Section 5.4.7 of the BA. One of the objectives of fire suppression activities shall be protection of salamanders and the aquatic habitat at upper Garden Canyon pond, in Scotia Canyon, or other salamander localities possibly affected by fire at Fort Huachuca. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

3. The Fort shall meet the objectives contained in the Endangered Species Management Plan for the Sonora tiger salamander.

4. The Fort will maintain boulders placed around the pond's perimeter at Upper Garden Canyon Pond to prevent vehicles from driving through the habitat.

5. The Fort will maintain a closure to vehicle travel at Gate No. 7.

6. The Fort has amended its Fishing Fact sheet and the Fort Huachuca web site to read: "i. Live fish and salamanders may not be transported or used as bait on Fort Huachuca. Capture, transport, or release of salamanders is strictly prohibited. This appears in bold. The "Fishing Facts will include this provision in annual updates.

7. The Fort will maintain the permanent all-weather sign posted at upper Garden Canyon pond. The sign contains the following information: 1) Fishing, use of nets, and capture or release of salamanders or fish is prohibited, and 2) Off-road vehicle use is prohibited.

8. The Fort will monitor take of Sonora tiger salamanders and document any disturbance of salamanders or salamander habitat. Results of this and other monitoring required will be reported to the Service following the reporting requirements in the proposed action.

9. The Fort will establish a schedule and implement, as soon as possible prescribed burns or fuels management to reduce fuel loading in Fort Huachuca woodlands.

Conclusion

After reviewing the current status of the Sonora tiger salamander, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Sonora tiger salamander. No critical habitat is designated for this species, thus none will be affected. Our conclusion of "not likely to jeopardize is based on the following:

1. Only one of about 50 salamander breeding sites is located at Fort Huachuca.

2. The Fort prohibits off-road vehicle use, transport and release of live fish and salamanders, and has proposed other conservation measures to reduce the threats to the Sonora tiger salamander.

3. The threat of wildfire is expected to be reduced through a comprehensive fire management plan that calls for prescribed fire and reduction of fuel loads. Execution of the plan will help reduce the chance of catastrophic stand-replacing fire that could adversely affect salamander habitat on and off-post.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out of an

otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Fort Huachuca so that they become binding conditions of any grant or permit issued to any applicant, permittee, or contractor, as appropriate, for the exemption in section 7(o)(2) to apply. The Fort has a continuing duty to regulate the activity covered by this incidental take statement. If the Fort (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant, permittee, or contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, Fort Huachuca must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(I)(3)].

Amount or Extent of Take

Take of Sonora tiger salamander could occur in the form of harm, harassment, injury, or death resulting from 1) escaped prescribed fire or managed natural fire, and 2) decisions made during fire suppression. The Service anticipates loss of the entire aquatic population of Sonora tiger salamanders at Upper Garden Canyon Pond once during the life of the project due to the causes above.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. This biological opinion does not authorize any form of take not incidental to implementation of the proposed action as described in this opinion and in ENRD (2002).

Effect of the Take

The Service has determined that the level of anticipated take is not likely to jeopardize the continued existence of the Sonora tiger salamander. If the entire aquatic population at Upper Garden Canyon Pond was lost due to the above causes, the pond would likely be recolonized as terrestrial salamanders returned to the pond to breed.

Reasonable and Prudent Measures

The Service believes that no reasonable and prudent measures are necessary, because the conservation measures proposed by Fort Huachuca include all possible measures to minimize impacts of incidental take of the Sonora tiger salamander. Therefore, because there are no reasonable and prudent measures, there are no terms and conditions.

If the incidental take anticipated in the paragraph entitled "Amount or Extent of Take is met, the Fort shall immediately notify the Service in writing. If, during the course of the action, the level of anticipated incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation. In the interim, the Fort must cease the activity resulting in the take if it is determined that the impact of additional taking will cause an irreversible and adverse impact on the species. Fort Huachuca must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendations provided here does not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the Sonora tiger salamander. In furtherance of the purposes of the Act, we recommend consideration of the following actions:

1. The Fort could study the movements and habitat use of terrestrial salamanders in and near Upper Garden Canyon Pond.

2. The Fort could continue to actively participate in the preparation and implementation of the Sonora Tiger Salamander Recovery Plan.

3. If the Sonora tiger salamander is found breeding at sites other than Upper Garden Canyon Pond on Fort Huachuca, the Fort should, in accordance with 50 CFR 402.16(b), reinitiate this consultation, as the Service believes this would represent new information revealing that the effects of the action may affect the salamander in a manner or to an extent not considered herein.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitat, the Service requests notification of the implementation of any conservation recommendations.

(Note: surveys for Sonora tiger salamander that involve capture or take require appropriate permits from the Service and Arizona Game and Fish Department.)

SOUTHWESTERN WILLOW FLYCATCHER (*Empidonax traillii extimus*)

Status of the Species

The southwestern willow flycatcher is a small passerine bird (Order Passeriformes; Family Tyrannidae) measuring about 5.75 inches in length from the tip of the bill to the tip of the tail and weighing only 0.4 ounce. It has a grayish-green back and wings, whitish throat, light gray-olive breast, and pale yellowish belly. Two white wingbars are visible (juveniles have buffy wingbars). The eye ring is faint or absent. The upper mandible is dark, the lower is light yellow grading to black at the tip. The subspecies was listed as endangered in 1995 (USFWS 1995a). Critical habitat was designated on July 22, 1997, and included 18 critical habitat units totaling 599 river miles in Arizona, California, and New Mexico. In Arizona, critical habitat was designated along portions of the San Pedro River, Verde River, Wet Beaver Creek, West Clear Creek, Colorado River in the Grand Canyon, and Little Colorado River (USFWS 1997b). Critical habitat was set aside by the 10th Circuit Court of Appeals on May 11, 2001. The court ruled that the Service failed to consider all economic impacts of the designation. The Service decided to set aside critical habitat designated for the southwestern willow flycatcher in all states (California, Arizona, and New Mexico) until it can reassess the economic analysis.

One of four currently-recognized willow flycatcher subspecies (Phillips 1948, Unitt 1987, Browning 1993), the southwestern willow flycatcher is a neotropical migratory species that breeds in the southwestern U.S. from about April 1 to September 1 and migrates to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948, Peterson 1990, Ridgely and Tudor 1994, Howell and Webb 1995). The historical range of the southwestern willow flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja)(Unitt 1987). The flycatcher is a riparian obligate, nesting along rivers, streams, and other wetlands where dense growths of willow (*Salix* spp.), seepwillow (*Baccharis* spp.), buttonbush (*Cephalanthus* spp.), boxelder (*Acer negundo*), saltcedar, or other plants are present, often with a scattered overstory of cottonwood or willow. Tamarisk is an important component of the flycatchers's nesting and foraging habitat in Arizona.

In 2000, 270 of the 303 known nests built were placed in a tamarisk tree (Paradzick et al. 2001). In 2001, 323 nests were built in tamarisk, 79 in willow, and 2 in cottonwood (Smith et al. 2002). All nests at high elevation in Arizona were built in Geyer willow (*S. geyeriana*)(Paradzick et al. 1999). Flying insects, particularly Hymenoptera (ants, bees, and wasps), Diptera (flies), and Hemiptera (true bugs), are the most important prey of the southwestern willow flycatchers; however, they will also glean larvae of non-flying insects, such as Lepidoptera (butterflies and moths), from vegetation (Drost et al. 1998).

Unitt (1987) reviewed historical and contemporary records of *E. t. extimus* throughout its range, determining that it had "declined precipitously..." and that although the data reveal no trend in the past few years, the population is clearly much smaller now than 50 years ago, and no change

in factors responsible for the decline seem likely. Roughly 587 flycatcher territories occurred in 1997. Breeding by roughly 350 to 550 pairs occurs at about 88 sites (Service files). Most breeding sites include five or fewer breeding territories, and many are likely remnants of formerly much larger populations (Cooper 1997, Sferra et al. 1997, Sogge et al. 1997). Declining numbers have been attributed to loss, modification, and fragmentation of riparian breeding habitat, loss of wintering habitat, and nest predation and brood parasitism by the brown-headed cowbird (*Molothrus ater*)(Sogge et al. 1997, McCarthey et al. 1998). Habitat loss and degradation are caused by a variety of factors, including urban, recreational, and agricultural development, water diversion and groundwater pumping, channelization, and livestock grazing. Fire is an increasing threat to willow flycatcher habitat (Paxton et al. 1996). Fire frequency in riparian vegetation increases with dominance by saltcedar (DeLoach 1991), and water diversions or groundwater pumping that results in dessication of riparian vegetation (Sogge et al. 1997). The presence of livestock, range improvements such as waters and corrals, and agriculture provide feeding areas for cowbirds. These feeding areas, if near riparian habitats, coupled with habitat fragmentation, facilitate cowbird parasitism of flycatcher nests (Hanna 1928, Mayfield 1977, Tibbitts et al. 1994). After five years of cowbird trapping on the South Fork of the Kern River, California, nest parasitism rates dropped from 65 to 22 percent, nest success increased from 28 to 43 percent, and mean number of young fledged per female flycatcher increased from 1.04 to 1.72 (Whitfield et al. 1998).

The largest concentrations of willow flycatchers in Arizona in 2000 were near the confluence of the Gila and San Pedro Rivers (219 flycatchers, 119 territories); at the inflows of Roosevelt Lake (207 flycatchers, 115 territories); Gila River, Safford area (30 flycatchers, 15 territories); Topock Marsh on the Lower Colorado River (25 flycatchers, 15 territories); Verde River at Camp Verde (9 flycatchers, 5 territories); Alpine/Greer on the San Francisco River/Little Colorado River (7 flycatchers, 5 territories); Alamo Lake on the Bill Williams River (includes lower Santa Maria and Big Sandy River sites) (44 flycatchers, 24 territories); Big Sandy River, Wikieup (23 flycatchers, 16 territories), and Lower Grand Canyon on the Colorado River (14 flycatchers, 8 territories)(Paradzick et al. 2001).

Rangewide, the population is comprised of extremely small, widely-separated breeding groups including unmated individuals. For example, in Arizona, 57 percent (27/47) of the sites where flycatchers were found in 2000 (Paradzick et al. 2001) comprised five or fewer territories. In Arizona during the 2000 season, all but the "Salt River Inflow Site at Roosevelt Lake had 20 pairs or less (Paradzick et al. 2001). Rangewide, 81 percent of all sites from 1993 to 1999 had five or fewer flycatcher territories present at the site (Sogge et al. 2000).

Willow flycatchers no longer occur at 40 of the 182 sites located or tracked rangewide since 1993 (USFWS 2001b). All but two of these sites had less than five flycatcher territories present. The two exceptions (PZ Ranch on San Pedro River and Colorado River Delta at Lake Mead) were destroyed by fire and lake inundation, respectively; however, many more than five territories will be lost at Roosevelt Lake in the near future.

In 2001, a total of 426 nesting attempts were documented in Arizona at 40 sites (Smith et al. 2002). Of the 329 attempts that were monitored, 191 fledged young, 114 failed, and 24 had unknown outcomes. Causes of nest failure included predation (n=82), nest abandonment (n=10), brood parasitism (n=6), infertile clutches (n=12), weather (n=2), and other causes (n=1). Cowbirds may have contributed to other abandoned nests, but no direct evidence was detected.

Intensive nest monitoring efforts in California, Arizona, and New Mexico have shown that cowbird parasitism or predation can often result in failure of the nest; reduced fecundity in subsequent nesting attempts; delayed fledging; and reduced survivorship of late-fledged young. Cowbirds have been documented at more than 90 percent of sites surveyed (Sogge and Tibbitts 1992, Sogge et al. 1993, Camp Pendleton 1994, Muiznieks et al. 1994, Sogge and Tibbitts 1994, T. Ireland 1994 *in litt.*, Whitfield 1994, C. Tomlinson 1995 *in litt.*, Griffith and Griffith 1995, Holmgren and Collins 1995, Kus 1995, Maynard 1995, McDonald et al. 1995, Sferra et al. 1995, Sogge 1995a, b, San Diego Natural History Museum 1995, Stransky 1995, Whitfield and Strong 1995, Griffith and Griffith 1996, Skaggs 1996, Spencer et al. 1996, Whitfield and Enos 1996, Sferra et al. 1997, McCarthey et al. 1998). The probability of a southwestern willow flycatcher successfully fledging its own young from a cowbird parasitized nest is low (i.e., <5 percent). Also, nest loss due to predation appears consistent from year to year and across sites, generally in the range of 30 to 50 percent. Documented predators of southwestern willow flycatcher nests identified to date include common king snake (*Lampropeltis getulus*), gopher snake (*Pituophis melanoleucus affinis*), and Cooper's hawk (*Accipiter cooperii*)(Paxton et al. 1997, McCarthey et al. 1998, Paradzick et al. 2000).

Cowbird trapping has been demonstrated to be an effective management strategy for increasing reproductive success for the southwestern willow flycatcher as well as for other endangered passerines (e.g., least Bell's vireo [*Vireo bellii pusillus*], black-capped vireo [*V. atricapillus*], golden-cheeked warbler [*Dendroica chrysoparia*]). It may also benefit juvenile survivorship by increasing the probability that parents fledge birds early in the season. Expansion of cowbird management programs may have the potential to not only increase reproductive output and juvenile survivorship at source populations, but also to potentially convert small, sink populations into breeding groups that contribute to population growth and expansion.

For further information on the ecology, range, status, and threats to this subspecies, refer to Brown (1988), Harris (1991), Harris et al. (1987a, b), McCarthey et al. (1998), Paradzick et al. (1999), Paxton et al. (1996), Sferra et al. (1997), Sogge et al. (1997), Stoleson and Finch (1998), Tibbitts et al. (1994), Unitt (1987), Uyehara et al. (1998), and USFWS (2001b).

Environmental Baseline

Riparian habitat suitable for nesting southwestern willow flycatchers is generally lacking at Fort Huachuca. Russell Duncan (in SAIC 1998a) reported a small patch of marginal habitat (no more than 10 acres of cottonwoods and wetland vegetation) on the West Range near Highway 90 just north of the main gate; however, further analysis suggested the site may not be suitable habitat

(EEC 2000b). Avian surveys have not been conducted at the site. This patch of riparian woodland burned in May 1999. The riparian vegetation is likely to recover and may develop into potential habitat after several years. Marginal habitat for flycatchers may also occur on-post at Gravel Pit Pond and Middle Garden Canyon Pond. These areas were classified as unsuitable nesting habitat through an on-sight evaluation based on current described and classified plant species composition and habitat structure used by the southwestern willow flycatcher for nesting (EEC 2000b).

In 1996, flycatchers were found on the San Pedro near St. David, and in 1997, one flycatcher nest was found near Kingfisher (or Young-Block) ponds in the SPRNCA near the Highway 90 crossing (McCarthey et al. 1998), however it was abandoned in July. A dead cowbird chick was found in the abandoned nest (SAIC 1998a). Early in the season, two territorial males were found upstream, and one was downstream of Kingfisher ponds (T. McCarthey, AGFD, pers. comm., 1997). SAIC (1998b) conducted flycatcher surveys along 17.1 miles in six reaches of the upper San Pedro River in May to July 1997. Surveys were conducted according to Service protocol in five of the six reaches. No flycatchers were detected during these surveys. In 1998, one flycatcher was detected at Kingfisher ponds on June 8, but it is unknown if this bird was a migrant or a breeding bird. An apparent migrant was seen on June 4 at Hereford Bridge, but was not observed in subsequent surveys (Paradzick et al. 1999). Also in 1998, three territorial males were found on the San Pedro River at Apache Powder Road, just north of the SPRNCA, but it is not known if these birds were paired or if nests were present (T. McCarthey, pers. comm., 1998). In 1999, two willow flycatchers, probably migrants, were detected in late May and early June at Kingfisher Ponds (T. McCarthey, pers. comm., 1999). EEC, contracted by the Fort in 2000 and 2001, conducted comprehensive surveys for the species on the SPRNCA. No southwestern willow flycatchers were detected along the SPRNCA during 2000 and 2001 surveys. However, an incidental sighting was observed by Jack Whetstone (U.S. BLM) while conducting weekly Monitoring Avian Productivity and Survivorship (MAPS) at the Banding Station near Kingfisher pond both in August 2000 and 2001 (Whetstone, pers. comm., 2000, 2001).

A wildfire just north of the Highway 90 bridge destroyed 780 acres of riparian woodlands and grasslands in late May and June 1998. The fire was just downstream of where flycatchers were found in 1997. Another fire, apparently caused by a downed power line, burned about 800 acres in the SPRNCA in March 1999.

The lower San Pedro River is relevant to this consultation because of the groundwater pumping issue, described in detail in the Environmental Baseline and Effects of the Proposed Action for the Huachuca water umbel. If flows and discharge to the upper San Pedro River decline due to the effects of the Fort's activities, a relatively small reduction in flows could be reflected downstream in the lower San Pedro River, as well (discussed in detail in the following Effects of the Proposed Action). The lower San Pedro River is one of the most important sites for the southwestern willow flycatcher. There were 219 flycatchers and 119 territories found on the lower San Pedro River in 2001. A total of 107 flycatchers were known to fledge from nests on the lower San Pedro River in 1998 (Paradzick et al. 1999) and 254 flycatchers fledged in 2001 (Smith et al. 2002). In 1997, flycatchers nested primarily in saltcedar on the lower San Pedro

River, but a few nests were found in buttonbush and willow (McCarthey et al. 1998). A reasonable and prudent alternative in the Service's biological opinion to the Bureau of Reclamation on proposed modifications to Roosevelt Dam required Reclamation to acquire and protect habitat for the flycatcher. In response, Reclamation provided a grant to The Nature Conservancy to acquire and manage an 820-acre site encompassing riparian habitat near Dudleyville, downstream of the Aravaipa confluence. This site, known as the San Pedro River Preserve, is part of a larger reach of the San Pedro River, 11.3 miles in length, from the Gila River confluence to about 1.5 miles south of the Aravaipa confluence, that supports a rich and diverse riparian community and includes all of the important flycatcher sites on the lower river.

The few southwestern willow flycatchers on the upper San Pedro River as compared to the lower San Pedro River may be a result of the relatively narrow corridor of riparian forest; a lack of understory in most areas, and a history of grazing that probably reduced understory foliage density on the upper San Pedro River. In addition, saltcedar, which is an important nesting substrate on the lower San Pedro, is relatively scarce on the upper San Pedro River. Since removal of most cattle after establishment of the SPRNCA, apparent foliage density in the understory has been increasing, with resulting increasing quality of flycatcher habitat. Nesting by riparian bird species has increased in a relatively short time (EEC 2001b). If this trend continues, more flycatchers will likely be found in the SPRNCA. The upper San Pedro River may serve as a migration corridor for some birds moving between wintering grounds in Latin America and the lower San Pedro or other sites to the north; however, Skagen (1995) recorded no willow flycatchers on the upper San Pedro River during April and early May 1989 to 1994, and few flycatchers were detected during surveys from 1996 to the present (see summary above).

The Babocomari River has not been well surveyed for southwestern willow flycatchers; however, most of the habitat on the river is probably unsuitable due to intermittent flows and lack of sufficient riparian vegetation cover (Dave Krueper, BLM, pers. comm., 1998). Lack of permanent flow and suitable riparian vegetation downstream of Huachuca City is attributable to groundwater pumping by Huachuca City, Fort Huachuca, and Sierra Vista (Schwartzman 1990). However, information is inadequate to determine if this reach of the river might be suitable flycatcher habitat if groundwater pumping ceased. The Babocomari Cienega, located on the Babocomari River upstream of Huachuca City at the Babocomari Ranch, may have potential to support nesting southwestern willow flycatchers (D. Krueper, pers. comm., 1998). The area consists of an impoundment, possibly an impounded spring, surrounded by a healthy stand of cottonwoods, and farther upstream, a thick stand of short willows (Susan Skagen, USGS, Biological Resources Division, pers. comm., 1998). Avian surveys from April 3 to May 14 over a four year period (1989, 1991, 1993, 1994) resulted in no observations of willow flycatchers (Skagen 1995), but southwestern willow flycatchers do not begin building nests until late May. Riparian woodlands above and below the cienega consist mostly of decadent, old cottonwoods and a relatively low proportion of foliage density in the understory. This may reflect a lack of recruitment possibly due to heavy grazing in the area (Skagen 1995; S. Skagen, pers. comm., 1998). However, a decline in groundwater elevation could have the same effect on cottonwood demographics. The cienega is occupied by the Canelo Hills ladies'-tresses, a species discussed in Appendix 1.

Cowbirds readily fly up to four miles between feeding and breeding areas (Rothstein and Verner 1984) and are capable of daily movements of more than five miles (Cook et al. 1997). Livestock and livestock handling facilities tend to attract brown-headed cowbirds, leading to a greater incidence of nest parasitism than would otherwise occur. Grazing and pastures create bare ground and open areas preferred by cowbirds. Brown-headed cowbirds, historically associated with bison, have adapted to expansion of agriculture and have experienced rapid population growth and range expansion in this century (Lowther 1993). About 50 to 60 horses are grazed on three pastures, totaling 1,433 acres, located northwest of the cantonment area of Fort Huachuca. Horses are grazed on the pastures from March to October. During the winter and early spring the horses are maintained in a corral in the same area. The pastures are located about 11 to 13 miles west of the San Pedro River, six miles southeast of the Babocomari Cienega, and about four miles from the cottonwood stand reported by Duncan (1997 in SAIC 1998a) as marginal flycatcher habitat. The Fort has monitored the pastures on several occasions for cowbirds, but only one transient bird was observed (SAIC 1998a). Brown-headed cowbirds were common at the Babocomari Cienega and on the upper San Pedro River in April and May 1989 to 1994 (Skagen 1995) and on the upper San Pedro River in May and June 1997 (SAIC 1998b). McCarthey et al. (1998) report that brown-headed cowbirds were present at the flycatcher localities on the upper San Pedro River in 1997; and the one nest in 1997 was parasitized by cowbirds (SAIC 1998a). In 1998, as part of the reasonable and prudent alternative for the Roosevelt Dam biological opinion, the Bureau of Reclamation issued a contract for operation of two cowbird traps on the upper San Pedro River to reduce cowbird populations. A total of 164 cowbirds were trapped from April 1 to July 31, 1998, at the two traps (Susan Sferra, Bureau of Reclamation, pers. comm., 1998).

Sections on hydrology in the Environmental Baseline for the Huachuca water umbel are included here by reference.

Effects of the Proposed Action

Effects of the proposed action can be segregated into two parts: effects of groundwater pumping and effects of training activities. Discussions of the former follow closely from the effects described for the Huachuca water umbel and include important indirect, interrelated and interdependent, and cumulative effects. Effects of training activities are fairly minor because no flycatchers have been found on the Fort, the potential to find breeding flycatchers on the Fort is very low, and training has minimal potential to affect habitat or flycatchers along the San Pedro River.

Effects of Groundwater Pumping

Although there are a number of hydrology modeling efforts and studies in the Sierra Vista subwatershed, no current modeling or study considers the conservation measures proposed by Fort Huachuca (reduce 3,077 AF of water usage by year 2011). In addition, these modeling efforts and studies do not consider the Upper San Pedro Partnership to reduce cumulative effects (3,306 AF of water usage). Most modeling and studies assumed that water usage will go

unmitigated. Therefore, the conclusions of these studies and modeling efforts must be updated in light of the proposal by both Fort Huachuca and actions taken by other members of the Upper San Pedro Partnership.

Portions of the Effects of the Proposed Action for the Huachuca water umbel pertinent to groundwater pumping are included here by reference. The following conclusions can be drawn from that discussion:

1. Annual low flows have declined on the upper San Pedro River at the Charleston and Palominas gages since 1942 or earlier (Jackson et al. 1987, Geraghty and Miller, Inc. 1995, Corell et al. 1996, Koehler and Ball 1998). From 1987 to 1994, low flows or periods of no flow became more frequent on the San Pedro River at Hereford, Charleston Bridge, and Fairbank. Inflows below Lewis Springs are diminished as a percentage of flows at Charleston gage (Sharma et al. 1997). Groundwater declines of three to six feet have occurred at Palominas and Contention, respectively, since 1987 (ADWR 1994).

2. Groundwater decline is reducing recruitment of cottonwoods, resulting in a loss of obligate and facultative wetland plants, saltcedar is apparently replacing cottonwood on young floodplains at Contention (ADWR 1994), and during July, 1997, the river just north of the Charleston Narrows was dry and cottonwoods there were stressed, apparently due to lack of water (SAIC 1998b).

3. Currently, groundwater use in the Sierra Vista subwatershed exceeds supply by roughly 5,144 acre-feet per year (ENRD 2002). As a result of groundwater overdraft, a cone or cones of depression in the groundwater aquifer have formed under Fort Huachuca and Sierra Vista that are about 7.5 square miles in size and up to 90 feet deep. The cone(s) of depression has probably not reversed the flow of groundwater to the San Pedro River, but it captures mountain front recharge that otherwise would flow to the river and has likely reduced the hydraulic head adjacent to the river (ADWR 1991, 1994, ASL 1995, Fenske 1998). The cone of depression has affected flow patterns in the Babocomari River in the vicinity of northern Huachuca City and the Fort, where base flow is severely depleted or absent during the dry season (Schwartzman 1990).

4. Possible causes of observed declines in base flow on the San Pedro River include: 1) changes in runoff from the watershed due to changes in watershed condition; 2) influences of near-stream groundwater pumping for agricultural purposes; 3) changes in water use in Mexico; 4) changes in riparian vegetation along the river, and 5) groundwater pumping from the regional aquifer (Jackson et al. 1987, ASL 1994). Jackson et al. (1987), Sharma et al. (1997), and MacNish (1998) believe that groundwater pumping outside of the SPRNCA, particularly in the Hereford/Palominas area, is the most important causal factor in observed declines in base flow. The San Pedro Expert Study Team (1999) believe the Fort Huachuca and Sierra Vista cone of depression began reducing the hydraulic head at the river in the 1960s or 1970s; while MacNish (1998)

presents evidence that base flow in the Lewis Springs to Charleston reach began declining due to the cone of depression about 1990. The importance of the Fort Huachuca/Sierra Vista cone of depression as a causal factor in current observed base flow declines is uncertain (ADWR 1991, ASL 1994, Fenske 1998, Koehler and Ball 1998); however, modeling by WESTEC (1996) suggested municipal and military users were only responsible for six percent of the historic loss of river flow through 1988.

5. Groundwater modeling efforts suggest that if groundwater pumping in the Fort Huachuca and Sierra Vista area has not yet significantly affected flows, it is predicted to do so unless those effects are mitigated. Reaches of the San Pedro River could become intermittent where perennial flows now occur, and groundwater elevation under the river could decline. The reach from Charleston north past the Babocomari confluence is most at risk, followed by the reach from Highway 90 to Charleston. Because of a clay deposit under at least some portions of the river, future changes in base flow in the reach from Hereford to Highway 90 will probably be linked more to the future of irrigated agriculture in the area than effects of the Fort Huachuca and Sierra Vista cone of depression. In the absence of a concerted effort to reverse current trends, the most likely future scenario is one of continued water use in excess of supply, continued enlargement of the cone of depression under Fort Huachuca and Sierra Vista, and in time dewatering of portions of the San Pedro River in the Sierra Vista subwatershed. The Sierra Vista and Fort Huachuca effluent recharge projects are expected to delay the effects of pumping and the cone of depression on river base flow for decades. However, uncertainties about how the clay deposit may affect recharge, and uncertainties surrounding future conditions and the feasibility of recharging effluent over the long term make it difficult to accurately predict how well and for how long the project will delay those effects. As long as water use exceeds supply, the riparian habitats and base flow of the San Pedro River are threatened. In the long-term, if the cone of depression continues to grow, base flows and groundwater elevation under the San Pedro River are expected to decline, with associated loss of wetland and riparian vegetation and changes in species composition (ADWR 1994, Stromberg et al. 1996). However, the growth in the groundwater deficit in the subwatershed appears to have been reversed.

6. Many viable water management options exist to mitigate the effects of groundwater withdrawals, and many have been implemented or are in the planning stages (Fluid Solutions 2002). However, prompt development and implementation of a comprehensive strategy to limit pumping and increase recharge is crucial to offset the current deficit and projected increased water demands in the subwatershed (see Effects of the Action for the Huachuca water umbel.)

Where the effects of the proposed action for the flycatcher depart from that of the water umbel is in regard to timing of the effects. The water umbel is a semi-aquatic obligate wetland plant. This group of plants would be the first to be adversely affected by declining flows (ADWR 1994, Stromberg et al. 1996). The southwestern willow flycatcher and its habitat could probably

sustain small declines in groundwater elevation or flow in most areas, and thus would not be affected as rapidly as the water umbel. Also, flycatchers exhibit nest site fidelity (Sogge et al. 1997), and may return to a site to nest even though the habitat has declined or is degraded.

Southwestern willow flycatchers nest in dense riparian vegetation typically near surface water or saturated soil. In low elevation sites in Arizona (includes the upper San Pedro River), nests are most often found in nonindigenous saltcedar. However, only 15 percent of nests monitored in 1997 were located in monotypic stands of nonindigenous species. Although nests are typically placed in saltcedar, often other native tree species, such as cottonwood and willow are present (Sogge et al. 1997, McCarthey et al. 1998, Paradzick et al. 1999). As summarized above, flows have declined, recruitment of cottonwoods has been affected, and saltcedar may be replacing cottonwood in some areas. Further changes in southwestern willow flycatcher habitat on the lower San Pedro River could result if groundwater pumping in excess of recharge continues. Declining water tables have a disproportionate effect on obligate riparian trees, such as cottonwood and willows, which depend on relatively shallow groundwater (Busch et al. 1992, Snyder et al. 1998). Stromberg et al. (1996) predicted that groundwater declines on the San Pedro River of one and three feet would result in 37 and 51 percent declines, respectively, in potential habitat for juvenile Goodding willow (*S. gooddingii*). Declines of six feet would eliminate seedling recruitment sites for cottonwood and willow (ADWR 1994). Groundwater declines of this magnitude have been observed at Palominas and Contention (ADWR 1994). Habitat of plants characteristic of deep groundwater (i.e., velvet mesquite, *Prosopis velutina*, hackberry, *Celtis reticulata*, and sacaton, *Sporobolus contractus*) and upland species (i.e., catclaw acacia, *Acacia greggii*, and rabbitbrush, *Chrysothamnus nauseosus*) was predicted to increase with increasing depth to groundwater (Stromberg et al. 1996). Under continuing groundwater decline, cottonwood and willow establishment would become restricted to the bottom of the river channel in a narrow band, followed by elimination of recruitment and decline of existing stands (ADWR 1994).

Based on the observation that saltcedar is replacing cottonwood in areas of groundwater decline of about six feet (ADWR 1994), cottonwood and willow communities could change to a community with young stands of saltcedar in the understory with an aging stand of mature cottonwoods and willows in the canopy. Under this scenario, the vegetation structure could still be adequate for southwestern willow flycatchers, depending on the height and density of the resulting saltcedar stands. However, if groundwater declined six feet, surface flows would likely become intermittent. Periods of no flow would be most likely to occur in May to early July when birds would be establishing territories and nesting. Lack of surface water would likely make these areas less suitable or unsuitable for nesting flycatchers. Increasing periods of no flow in early summer were discussed in the Effects of the Proposed Action for the Huachuca water umbel. Relatively small declines in groundwater elevation would result in increased periods of no flow first where flows are currently very low or occasional periods of no flow already occur, such as at the Tombstone gage (see discussion for Huachuca water umbel). At Lewis Springs, near where flycatchers were found in 1997, flows are about 40 percent of those at the Charleston gage, but a lack of no flow records suggests flycatcher habitat at this site might be more resilient to groundwater decline than at the Hereford or Tombstone gage.

In the long-term, if groundwater use continues in excess of supply, the cone of depression under Fort Huachuca and Sierra Vista will continue to grow and will capture an increasing percentage of the groundwater (including effluent recharge) that otherwise would flow into the floodplain aquifer and the San Pedro River. As the cone of depression spreads towards the river it would cause gaining reaches to become losing reaches and result in further groundwater declines. Based on Don Pool's work and the presence of a clay deposit, base flow near the Babocomari confluence may be affected first. The perennial reach upstream from the Babocomari confluence to Charleston may be the next reach affected, followed by the reach from Highway 90 to Charleston. The City and the Forts's effluent recharge projects are expected to mask the effects of pumping by bolstering base flow from at least Highway 90 to Fairbank (ASL 1998), but the length of time the project will be effective at masking those effects is uncertain. In time, if groundwater withdrawals continue to exceed supply, groundwater elevation and base flow are expected to decline enough to eliminate surface flow except during storm runoff, eliminate recruitment of cottonwood, willow, and saltcedar, and ultimately result in the death of obligate wetland plants (ADWR 1994, Stromberg et al. 1996). Cottonwoods and willows typically do not grow where groundwater is deeper than about eight feet (Anderson 1995). If groundwater declines of this magnitude occurred, mortality of cottonwoods and willows is expected. Flycatcher habitat could be eliminated under this scenario (U.S. BLM 1998). Similar loss of cottonwood and willow riparian habitat has occurred on the upper Santa Cruz River as a result of declining groundwater elevation (Stromberg et al. 1996.)

The timing of when loss of habitat might occur is disputed. The San Pedro Expert Study Team (1999) believe flows have been affected by the Fort Huachuca and Sierra Vista cone of depression since the 1960s or 1970s; MacNish (1998) believes the cone began affecting the river about 1990; but modeling by WESTEC (1996) estimated that municipal and military users were only responsible for six percent of the historic loss of river flow through 1988. Whether declines currently attributable to the Fort Huachuca/Sierra Vista cone of depression are currently great enough to adversely affect flycatcher habitat is unknown. ASL (1998), using MODFLOW and assuming a successful Sierra Vista effluent recharge project, showed that base flows in the reach from Lewis Springs to at least Fairbank may begin to decline significantly by 2020. Absent the (then) proposed Sierra Vista effluent recharge project, base flow in the same reach begins to decline by 2000.

Very small declines in base flow could turn perennial reaches of the river into intermittent reaches. Table 1 of San Pedro Expert Study Team 1999, which shows the 90 driest days within the last 10 years at Charleston, illustrates that declines of less than 0.1 cfs will result in intermittent flows in this dependably perennial reach. These periods of no flow would occur when flycatchers are selecting nest sites and breeding, and are particularly sensitive to changes in flow patterns.

Many measures to reduce water use or increase recharge are planned or have been implemented in the Sierra Vista subwatershed that have the potential to delay adverse effects in specific reaches. The likelihood that enough measures can or will be implemented soon enough to prevent declines in base flow and loss of habitat will depend on adequate funding and technical

feasibility of the measures (see discussion for the water umbel). As discussed for the Huachuca water umbel, under the most likely future scenario, threats to the base flows of the river, and thus habitats of the willow flycatcher will remain unless a concerted effort is made to manage water resources. The Service believes that solutions to this problem are available and feasible at this time. However, if programs are not implemented soon, halting the growth and spread of the cone of depression will be impractical or impossible, and dewatering of portions of the river through the habitat area in the subwatershed will be inevitable.

To partially address this problem, the Fort has developed an Army Water Resources Management Plan and will participate in the development of an upper San Pedro Basin conservation plan with partners in the subwatershed. The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats.

As discussed in the Environmental Baseline, groundwater pumping at the Fort and by Sierra Vista may have degraded riparian woodlands on the Babocomari River downstream of Huachuca City (Schwartzman 1990). Continued groundwater pumping at current rates is predicted to result in groundwater declines of 5.8 to 11.5 feet in 50 years, and 8.6 to 20.5 feet in 100 years in an area of considerable riparian vegetation downstream of Huachuca City (Schwartzman 1990). These declines are large enough to prevent recruitment of cottonwoods and willows, and will likely result in death of mature riparian trees (ADWR 1994, Anderson 1995, Stromberg et al. 1996). Whether this area would have potential to support flycatchers absent groundwater pumping is unknown.

The Babocomari Cienega contains potentially suitable habitat for southwestern willow flycatcher, but no flycatchers have been recorded there. The cienega is considerably upslope and upstream of the wells at Fort Huachuca and Sierra Vista. Brenda Houser, USGS (1998) investigated the geology and hydrology of the area. Probably the most important structure in regard to the hydrology of the area is an east-west fault on the north side of the Babocomari River that brings relatively impermeable Tertiary conglomerate and volcanic rocks on the south side of the river in contact with Paleozoic limestone and dolomite units on the north. Houser (1998) suggests that "groundwater from the Mustang Mountains on the north probably flows southward in fractures or solution channels in the Paleozoic and Mesozoic bedrock, and in the saturated zone of the gravelly upper Tertiary and Quaternary piedmont sediments. Where the water intersects the fractured zone of the fault, it would be forced upward along the more permeable fracture zone by the presence of impermeable conglomerate and volcanic rocks on the south side of the fault. The water would then flow along the base of Quaternary terrace gravel deposits until it intersects the ground surface on the north side of the Babocomari River and emerges as springs and seeps. ADWR (1991) also notes the presence of a volcanic dike in the area that apparently causes a pooling of groundwater and forces water to the surface forming cienega conditions. Trends in groundwater elevation have not been investigated; however Skagen (pers. comm., 1998) noted decadent stands of cottonwoods above and below the cienega where recruitment is apparently low due to livestock grazing, groundwater declines, or other factors. Although data is insufficient to make conclusions, because the cienega is considerably

upstream of wells at Fort Huachuca and the Sierra Vista wells, faulting and geology suggest much of the water in the area comes from the Mustang Mountains, a geological feature forces groundwater to the surface at this site, and the river flows from the west, it is unlikely that groundwater pumping by Fort Huachuca or Sierra Vista currently affects or would in the future affect riparian habitat at or near the cienega. If future groundwater pumping in excess of supply resulted in the cone of depression capturing groundwater inflow to the area, it would probably occur well after effects to the San Pedro River are manifested.

As discussed in the Environmental Baseline, the lower San Pedro River is one of the most important sites for southwestern willow flycatchers. The upper and lower reaches of the San Pedro River are hydrologically connected, so that effects in the upper basin could potentially affect flows and riparian habitat in the lower basin. Most of the San Pedro River from Benson northward is intermittent (ADWR 1991), thus flow between the basins occurs primarily as subsurface flow and flood flow. The reach from near the Aravaipa confluence downstream to the Gila River, where the most important flycatcher habitat exists, is described as intermittent by ADWR (1991), but perennial pools and river segments occur in adequate numbers to support fish populations. A perennial reach of about four miles in length occurs south of Redington where groundwater is forced to the surface by shallow bedrock. A perennial cienega habitat occurs at Cook's Lake approximately 1.5 miles downstream of the Aravaipa confluence (ADWR 1991).

Unmitigated groundwater pumping would be expected to affect the base flow of the upper San Pedro River. Flood flows are not affected by groundwater pumping. Flycatcher habitat in the lower basin is located primarily in the Winkelman subwatershed immediately upstream of the Gila confluence. Eighteen percent (7,054 AF) of the annual water volume that leaves the Sierra Vista subwatershed flows all the way to the Winkelman subwatershed (ADWR 1991), but this includes flood flows; base flow would be much less. Groundwater inflow across subwatershed boundaries in the lower San Pedro River is insignificant (ADWR 1991). Flow between subwatersheds might be greater if water use did not exceed water supply in the Sierra Vista subwatershed, but because of the presence of cones of depression it is unlikely that any increased water supply would result in significant increases in subwatershed outflow. Even if the entire deficit (5,144 AF) was discharged as outflow from the Sierra Vista subwatershed, only about 20 percent would be expected to reach the Winkelman subwatershed. Annual water supply to the Winkelman subwatershed is 73,760 acre-feet, thus under this scenario, eliminating the deficit in the Sierra Vista subwatershed and diverting all of the gain to subwatershed outflow would only cause no more than an about two percent increase in annual inflow into the Winkelman subwatershed, under the most optimistic conditions.

Although the effects of groundwater pumping in the Sierra Vista subwatershed on downstream southwestern willow flycatcher habitat are uncertain, the best information available suggests that currently these effects are probably small or negligible. Effects of future groundwater pumping are predicted to be insignificant because base flow from the Sierra Vista subwatershed into the subwatershed where flycatcher habitat primarily occurs is very small and proposed regional and Fort Huachuca water management planning are expected to protect base flows in the Sierra Vista subwatershed.

Effects of Other Activities at Fort Huachuca

Activities other than groundwater pumping are not likely to cause significant adverse effects to the southwestern willow flycatcher or its habitat. Adverse effects are possible, but not likely to occur, as a result of wildfire ignited by military training that destroys flycatcher habitat or nests. Adverse effects could also potentially occur due to disturbance of flycatchers or habitat at ASA sites in the SPRNCA, and disturbance or loss of potential habitat near the main gate, at Gravel Pit Pond, and Middle Garden Canyon Pond.

As discussed for the Huachuca water umbel, fires are infrequently ignited on the East Range as a result of training (Figure 13). Area Zulu is a live fire impact area where fires could ignite from ordnance delivery. However, fires on the East Range are typically small and fire breaks around Zulu and on the eastern boundary of the installation make it highly unlikely that a fire ignited on the East Range would spread to the San Pedro River. Live munitions could also conceivably stray off course into the SPRNCA and start a fire. However, fires have never spread from the East Range to the San Pedro River, and fires have never been ignited on the San Pedro due to stray weapons fire. The Service believes the chance of these events occurring during the life of the project is insignificant. The chance of fire spreading from the northwestern boundary of the installation to the Babocomari Cienega is also unlikely due to the presence of Chihuahuan Desert scrub containing little fuel to carry fire between the installation boundary and the cienega.

If riparian woodland near the main gate recovers from the May 1999 fire, its future value as habitat for flycatchers is unknown. It may be too isolated from occupied habitat or may not develop adequate understory foliage density to support flycatchers. The Fort has proposed to survey for flycatchers at suitable habitats on-post. As this data is collected, a better analysis of effects resulting from on-post activities will be possible.

The Fort maintains 22 ASA sites within or on the boundaries of the San Pedro RNCA (Figure 3, 4). As described in the BA, ASA sites are where the capabilities of electronic systems are tested. ASA sites are located along road shoulders or previously disturbed sites. At each site typically one or two vehicles and four to six personnel would be deployed for no more than 11 days. Occasional exercises involve up to 20 vehicles, 50 support personnel, and 60 to 70 students. Vehicles sometimes are mounted with large antennae, or ground-mounted antennae up to 80 feet in height are erected. Sites are located next to the San Pedro River at the Charleston Road and the Highway 82 and 90 crossings; however, no suitable flycatcher habitat exists. If flycatchers nest immediately adjacent to ASA sites, the birds could be disturbed by training activities, particularly during an exercise involving many vehicles and personnel. Cigarettes discarded by personnel could potentially cause a fire and destruction of flycatcher habitat. Although unlikely, flycatchers could also potentially fly into an antennae and be killed or injured. These effects are mitigated by the Fort's commitment to not use ASA sites within 300 feet of southwestern willow flycatcher habitat from April 1 to September 1 of each year and to take precautions at ASA sites adjacent to suitable habitat, but farther than 300 feet, to minimize the chance that a fire occurs.

Cowbirds are not known to occur at the horse pastures (SAIC 1998a), and regional populations are not likely significantly enhanced by other activities at Fort Huachuca. If cowbirds are occasionally attracted to the horse corral, golf course, urbanized portions of the cantonment area, or other portions of the installation, any effects to regional cowbird populations and resulting increased parasitism is likely masked by farming and ranching activities off of Fort Huachuca. Although Skagen (1995) found cowbirds to be common on the upper San Pedro River and at the Babocomari Cienega, there does not appear to be a source population or significant attractant at Fort Huachuca.

As discussed for the Huachuca water umbel, watershed condition on the East Range is degraded in a band, about two to three miles in width, that runs across the range from the northwest to the southeast. Degraded watersheds can cause increased surface runoff and sediment transport, and decreased infiltration of precipitation (Gifford and Hawkins 1979, DeBano and Schmidt 1989, Belsky and Blumenthal 1997). Potentially, degraded watershed conditions on the East Range could result in higher peak flows, lower low flows, and sedimentation or erosion of the San Pedro and Babocomari Rivers. Such conditions could potentially lead to scouring of riparian vegetation or reduced flows during willow flycatcher breeding activity. However, studies by the Environment and Natural Resources Division at Fort Huachuca (1997a) indicate that most sediment eroded from the East Range is deposited along the east boundary and does not reach the San Pedro or Babocomari Rivers. The lower-elevation portions of the San Pedro River watershed outside of Fort Huachuca are much degraded due to development, a long history of livestock grazing, and conversion of grasslands to shrublands. The effects of watershed degradation on the East Range are probably largely masked by these regional watershed problems along the San Pedro River. Fort Huachuca is committed to a number of erosion conservation measures to reduce the affect of erosion on flycatcher populations. These include no off road vehicle travel on the installation and implementation of the East Range Watershed Improvement Plan which includes activities such as revegetation, installation of structures to slow erosion and trap sediment, placement of waterbars along roads, and closure of unneeded roads.

Indirect, Interrelated and Interdependent Effects

Groundwater Pumping

Indirect, interdependent, and interrelated effects of groundwater pumping are the same as that described for the Huachuca water umbel. Summarizing from that discussion, employees, contractors, and their dependents; businesses and their employees and dependents; and military retirees and their dependents that would not be in the Sierra Vista subwatershed but for the presence of Fort Huachuca use groundwater. Thus, the amount of groundwater pumped that is attributable to Fort Huachuca is more than what actually is withdrawn from wells on-post.

As detailed in the proposed action and Section 5 of the BA, Fort Huachuca proposes to implement conservation measures that total 3,077 AF and will completely offset almost all direct, indirect, interrelated and interdependent effects associated with its proposed action by the year 2011. Therefore, Fort Huachuca has committed to mitigate for a greater part of the deficit than what is attributable to them. The proposed 3,077 AF is actually 60 percent of the current estimated deficit. In addition, Fort Huachuca will offset all increased water pumpage associated with potential personnel/mission increases in the future.

Other Off-Post Activities

As discussed for the Huachuca water umbel, development attributable to Fort Huachuca may result in watershed degradation (Wang et al. 1997). Urban development can adversely affect biotic integrity and habitat quality in adjacent riparian systems (Rosgen 1994, Federal Interagency Stream Restoration Working Group 1998). Urbanization results in increased runoff, and resulting changes in flow regimes, water temperature, water quality, and channel morphology (Schueler 1994, Wang et al. 1997). These changes may affect recruitment and development of riparian woodlands that the southwestern willow flycatcher uses as nesting and foraging habitat.

Development in the subwatershed attributable to Fort Huachuca probably also contributes to increased recreational use of the SPRNCA and other areas of the San Pedro River corridor. Increased recreational use results in greater chance of fire, off-road vehicle damage to riparian habitats, and disturbance of flycatchers by recreationists.

Other Activities at Fort Huachuca

As discussed for the Huachuca water umbel, the Fort supplies support services for other DOD units. Many units also train at Fort Huachuca that originate at other installations or that train elsewhere. Support services provided to other DOD units, and off-post activities of training units are not considered interrelated and interdependent to the proposed action because they are basic DOD functions that would occur with or without the presence of Fort Huachuca.

Cumulative Effects

Groundwater Pumping

As discussed for the Huachuca water umbel, cumulative effects of groundwater pumping are even more important than indirect, interrelated, and interdependent effects. Although employment and effective population at Fort Huachuca are expected to increase by 500 jobs over the next 10 years, the population of the Sierra Vista subwatershed is expected to increase from the 1990 estimate of 51,400 to 73,900 in 2030 (San Pedro Expert Study Team 1999). Because the Fort is expected to grow very little, this increase cannot be attributed to the Fort; although it

is not possible to predict how growth in the subwatershed might be affected if the Fort was not present. Nevertheless, it is clear that growth in the area and subsequent increases in water usage have achieved momentum that is separate from any influence Fort Huachuca might have. The projected growth in water consumption in the subwatershed and the resulting continued deficit between water recharge and use pose the greatest threats to the southwestern willow flycatcher on the upper San Pedro River.

The Army anticipates the USPP conservation plan will maintain base flows in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act. The first working draft of the conservation plan is due in 2003. A variety of teams and partnerships, such as the Upper San Pedro Partnership, the San Pedro Expert Study Team, Advisory Panel on the Upper San Pedro Initiative, recommendations of the Water Issues Group, as well as designation of the San Pedro RNCA and negotiations on the ongoing Gila River adjudication all have provided direction, ideas, and incentive to protect the riparian resources of the upper San Pedro River. Taken together, they provide a framework for Fort Huachuca to work with other agencies, the City of Sierra Vista, and others to protect the flycatcher and its habitat on the San Pedro River. The Service believes the Fort will be successful in developing with others in the basin water management plans by 2003 that when implemented, will protect the flycatcher and its habitat. If the City of Sierra Vista's and Fort Huachuca's effluent recharge project work as anticipated, effects to the river from groundwater pumping should be delayed long enough to devise and implement these plans before the flycatcher or its riparian habitat are significantly affected.

Of great concern is the potential for additional agricultural development and associated pumping of groundwater in the floodplain of the San Pedro River in either the U.S. or Mexico portions of the river. Extensive acreage exists in Mexico and on private and state lands within the U.S. portion of the watershed that could potentially be developed for agriculture (San Pedro Expert Study Team 1999). This may become less of a threat if initiatives to designate irrigable lands as irrigation non-expansion areas or if purchase of lands or easements from willing sellers are implemented. As discussed in the 'Environmental Baseline a number of initiatives and planning processes are underway at local, state, Federal, and international levels that are expected to reduce cumulative effects due to groundwater pumping in the upper San Pedro River basin.

Effectiveness of Proposed Conservation Measures

The Fort is committed to implementing many conservation measures that would significantly reduce potential adverse effects to the southwestern willow flycatcher and its habitat.

1. The Fort will maintain existing fire breaks on the East Range.

2. The Fort will vigorously suppress any fire on the eastern third of the East Range, except in the impact area, and implement all portions of the proposed action and proposed conservation measures relevant to fire suppression.

3. If surveys confirm presence of southwestern willow flycatchers on Fort Huachuca, the Fort will take action to ensure that fire ignited on the training ranges does not spread to flycatcher habitat and will work with the Service to develop and implement a plan to prevent any take of flycatchers.

4. The Fort has assessed habitat suitability for flycatchers at Research, Development, Testing, and Evaluation (RDTE) survey points along the San Pedro River and none exists. Further habitat assessments will be conducted on a periodic basis, as needed.

5. Monitoring will be conducted following Section 5.4.4 of the BA. This includes habitat on Fort Huachuca, at the Babocomari Cienega, if permission is obtained, and throughout the SPRNCA in cooperation with the BLM. Surveys will adhere to Service protocol (Sogge et al. 1997). Surveys will include documenting flycatcher population size and distribution, identity of nesting birds (if banded), number of nesting attempts, clutch sizes, hatching success, fledgling success, causes of nest loss or failure, breeding season length, and habitat use.

6. The Fort will monitor habitat conditions in the SPRNCA and habit acquired or for which easements/permission to enter are obtained. Aerial photos (1"=500 feet) were taken in 2000 and will be taken of the riparian corridor in 2004 and 2008. Vegetation maps were developed in 2001 and will be constructed from photo series within one year of obtaining the photographs. Resolution of the maps will be sufficient to map vegetation patches as small as 10 acres. Vegetation typing will be by plant species composition and vertical structure/foliage density. Sufficient ground-truthing will be conducted to assure reasonable accuracy of the mapping effort. Vegetation mapping in 2005 and 2009 will be accompanied by a trend analysis to determine gains or losses in flycatcher habitat.

7. The Fort will assist BLM or other land owners and managers of habitat on the upper San Pedro River with flycatcher habitat management, or restoration on retired agricultural lands, grazed areas, and in other areas where flycatcher habitat has been degraded or lost. Assistance will take the form of funding or technical assistance. All plans and agreements for projects funded will be coordinated with and approved by the Service in writing.

8. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements, and storm water recharge will balance out most direct, indirect, interdependent and interrelated effects. Cumulative effects should be addressed by regional efforts (communities and agencies), through the USPP, and other collaborative efforts.

Conclusion

After reviewing the current status of the southwestern willow flycatcher, the environmental baseline for the action area, the effects of the Fort's activities, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the southwestern willow flycatcher. No critical habitat is designated for this species, thus none will be affected. We present these conclusions for the following reasons:

1. The Fort has committed to implement their Army Water Resources Management Plan and to work with others to develop a regional conservation plan. The goal of the Army Water Resources Management Plan is to maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats. The Army's goal for the USPP conservation plan is to maintain base flows in the upper San Pedro River sufficient to sustain species and habitats protected by the Endangered Species Act.

2. The City of Sierra Vista and Fort Huachuca effluent recharge projects are expected to delay effects to river base flow and flycatcher habitats in a reach of the river that otherwise could be significantly affected by groundwater pumping at Fort Huachuca and Sierra Vista. Although these projects do not alleviate the long-term threat to flycatcher habitats on the San Pedro River, they are expected to provide decades to delay the manifestation of impacts and allow time for development and implementation of a plan to address long-term threats.

3. The Fort's proposed measures to mitigate for groundwater use attributable to them by 2011 should reduce almost all of the impacts of the Fort's presence on the San Pedro River.

Incidental Take Statement

Section 9 of the Act and Federal regulation following section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined in the same regulation by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take of a listed animal species that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of sections 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the

agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

Amount or Extent of Take

The likelihood that take of willow flycatcher will occur as a result of the proposed action is very low due to the Fort's conservation measures, described in the proposed action. Thus, no take of southwestern willow flycatcher as a result of the proposed action is anticipated.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information on listed species. The recommendations provided here do not necessarily represent complete fulfillment of the agency's section 2(c) or 7(a)(1) responsibilities for the southwestern willow flycatcher. In furtherance of the purposes of the Act, we recommend consideration the following actions:

1. The Fort could support basic research and monitoring of the southwestern willow flycatcher in the San Pedro River basin, including determining the status of the species in the Mexico portion of the basin, rates of cowbird parasitism, benefits of cowbird trapping, development of a quantitative model defining suitable habitat of the willow flycatcher on the San Pedro River, and other topics.

2. In the proposed mitigation measures, the Fort has proposed to assist the BLM and other land owners with habitat management or restoration of flycatcher habitat that has been degraded. Off-post projects that the Fort could consider funding include contacting the landowner at the Babocomari Cienega to inquire if the Fort can assist in riparian restoration at that site, and restoration or protection of riparian woodlands on the upper or lower San Pedro River, if approved by and coordinated with the landowner(s).

3. The Fort recognizes and supports the need to balance water use with water supply in the Sierra Vista subwatershed, and should consider encouraging other water users in the subwatershed to endorse, through the regional conservation planning effort, this goal.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, we request notification of the implementation of the conservation recommendation.

(Note: survey for Southwestern willow flycatchers via tape-recorded calls requires appropriate permits from Arizona Game and Fish Department and the Service.)

DISPOSITION OF DEAD OR INJURED LISTED ANIMALS

Upon locating a dead or injured threatened or endangered animal, initial notification must be made to the Service's Division of Law Enforcement, Federal Building, Room 8, 26 North McDonald, Mesa, Arizona (602/261-6443) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, a photograph, and any other pertinent information. Care must be taken in handling injured animals to ensure effective treatment and care, and in handling dead specimens to preserve biological material in the best possible condition. If feasible, the remains of intact specimens of listed animal species shall be submitted to educational or research institutions holding appropriate state and Federal permits. If such institutions are not available, the information noted above shall be obtained and the carcass left in place.

Arrangements regarding proper disposition of potential museum specimens shall be made with the institution prior to implementation of the action. Injured animals should be transported to a qualified veterinarian by a qualified biologist. Should any treated listed animal survive, the Service should be contacted regarding the final disposition of the animal.

CLOSING STATEMENT

This concludes formal consultation on the Department of the Army's proposed land use, military operations, and training range utilization at and near Fort Huachuca, Arizona, for 10 years. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may adversely affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by this action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation, if it is determined that the impact of such taking will cause an irreversible and adverse impact to the species. Any questions or comments should be directed to Doug Duncan (520) 670-4860 or Sherry Barrett (520) 670-4617.

Sincerely,

/s/ Brian Hanson
Acting Field Supervisor

James A. Marks, Brigadier General, U.S. Army 206

cc: Assistant Regional Director, Ecological Services, Albuquerque, NM (ARD-ES)
(Attn: Susan MacMullin)
Assistant Field Supervisor, Fish and Wildlife Service, Tucson, AZ
Michael Schoessler, Department of the Interior, Office of the Regional Solicitor, Albuquerque, NM

Director, Arizona Game and Fish Department, Phoenix, AZ
Regional Supervisor, Arizona Game and Fish Department, Tucson, AZ
Office Manager, Bureau of Land Management, San Pedro River Office, Sierra Vista, AZ
Field Office Manager, Bureau of Land Management, Tucson, AZ
City of Sierra Vista, Sierra Vista, AZ
Cochise County, Sierra Vista, AZ
State Director, Bureau of Land Management, Phoenix, AZ
District Ranger, Sierra Vista Ranger District, Coronado National Forest, Hereford, AZ
District Chief, Water Resources Division, Arizona District, United States Geological Survey, Tucson, AZ
Area Manager, Bureau of Reclamation, Phoenix, AZ (Attn: Bruce Ellis)

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APPENDIX 1. CONCURRENCES

The Service concurs with the Forts determinations of may affect, not likely to adversely affect for the spikedace, loach minnow, bald eagle, jaguar, and Canelo Hills ladies'-tresses. The rationale for these concurrences is detailed in the following discussions by species.

BALD EAGLE (*Haliaeetus leucocephalus)*

Status of the Species in the Action Area

The bald eagle does not nest in southern Arizona, and is very rarely seen during the summer. Consistent wintering areas have not been documented in southeastern Arizona during statewide, yearly winter surveys (Beatty 1997b *in litt.* ENRD 2002). However, in southeastern Arizona, the species is known to occur in winter in the Sulphur Springs Valley and has been observed at Parker Canyon Lake. No suitable nesting habitat or habitat for congregations of wintering birds exists on Fort Huachuca.

Effects of the Proposed Action

Because the bald eagle is only a transient visitor to Fort Huachuca during the winter months, direct mortality is unlikely. A bald eagle could collide with the Bergey wind turbine on the West Range or possibly with a vehicle, wind data tower or other man-made structure, but the possibility is low. If direct mortality of a bald eagle is detected, the Fort will enter into formal consultation. The lack of wintering or roosting habitat on or near the Fort precludes effects to potential or suitable bald eagle habitat.

Conclusion

The Service concurs with the Fort's determination that the proposed action may affect, but is not likely to adversely affect the bald eagle. This concurrence is based on the following:

1. There are no known nesting or roost sites nearby, therefore no disturbance of such sites is occurring;

2. Bald eagles rarely occur in southeastern Arizona; and

3. The chance that a bald eagle would be harmed by the proposed action is remote.

CANELO HILLS LADIES'-TRESSES (*Spiranthes delitescens*)

Status of the Species in the Action Area

This species is known from five sites at about 5,000 feet elevation in the San Pedro River watershed in Santa Cruz and Cochise counties, southern Arizona (Newman 1991; Mima Falk, Coronado National Forest, pers. comm., 1996). The total amount of occupied habitat is less than 200 acres. Four of the populations are on private land less than 23 miles north of the U.S. and Mexico border; one additional small site containing four individuals was discovered on public land in 1996 (Mima Falk, pers. comm., 1996). This site is located near a known population and may not be a distinct population. Potential habitat in Sonora, Mexico, has been surveyed but no *Spiranthes delitescens* populations have been found.

Four of the five populations of Canelo Hills ladies' tresses occur to the west of Fort Huachuca. These populations occur on Nature Conservancy, USFS (Coronado NF), and private land (Arizona Rare Plant Committee 2001). The fifth population occurs on private land at the Babocomari Cienega, about 1.5 miles north of the northwest corner of Fort Huachuca.

Threats to the Canelo Hills ladies'-tresses include groundwater pumping, water diversions, sand and gravel mining, recreation impacts, illegal collection, and invasion of cienega habitats by nonindigenous plant species, such as Johnson grass and Bermuda grass, *Cynodon dactylon* (USFWS 1997a). The nonindigenous Johnson grass is invading one *Spiranthes* site (Dave Gori, Arizona Nature Conservancy, in litt. 1993). This tall grass forms a dense monoculture, displacing less competitive native plants. If Johnson grass continues to spread, the Canelo Hills ladies'-tresses population at this site may be lost (Dave Gori, in litt. 1993). The effect of livestock grazing on the Canelo Hills ladies'-tresses is unclear. A *Spiranthes* population growing at a site grazed for more than 100 years was found to be larger and more vigorous than a population growing at a site ungrazed since 1969 (McClaran and Sundt 1992, Newman 1991). Limited numbers of populations and individuals threaten this taxon with demographic and environmental extinction as a result of stochastic events that are often exacerbated by habitat disturbance. For instance, the restriction of the species to a relatively small area in southeastern Arizona increases the chance that a single environmental catastrophe, such as a severe tropical storm or drought could eliminate populations or cause extinction.

Effects of the Proposed Action

The potential effects of groundwater use on the Babocomari Cienega were evaluated in the Huachuca Umbel section. Based on available data, it is unlikely that groundwater pumping by Fort Huachuca or Sierra Vista currently affects, or in the future would affect, riparian or wetland habitat at or near the cienega. This conclusion is based on: 1) the cienega being upstream of wells at Fort Huachuca and Sierra Vista; 2) faulting and geology suggests much of the water in the area comes from the Mustang Mountains (Houser 1998); 3) a geological feature that forces groundwater to the surface at this site (ADWR 1991); 4) the fact that the Babocomari River

flows from the west; 5) Fort Huachuca will implement conservation measures to offset their contribution to groundwater overdraft in the upper San Pedro River basin; 6) Fort Huachuca will request that the communities and agencies within the Sierra Vista Subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater overdraft by 2011 as well.

The chance of fire spreading from the northwestern installation boundary to the Babocomari Cienega is unlikely because of sparse and fine fuels between the installation boundary and the cienega. Also, the Fort's perimeter road and fuel breaks located in Training Area Juliet reduce the likelihood for fire to spread off the installation. Fire may be beneficial to this species.

Conclusion

The Service concurs with the Fort's determination that the proposed action may affect, but is not likely to adversely affect the Canelo Hills ladies'-tresses. We base this determination on the following:

1. Although all five populations of Canelo Hills ladies'-tresses occur near Fort Huachuca, none occur on the Fort or in areas proposed for off-post activities;

2. Available hydrological information suggests that groundwater pumping by Fort Huachuca is not likely to affect Canelo Hills ladies'-tresses habitat at Babocomari Cienega; and

3. The probability of other activities of Fort Huachuca, such as fires ignited on the West Range or aircraft crashes adversely affecting the Canelo Hills ladies'-tresses is remote.

4. Fire may be beneficial to Canelo Hills ladies'-tresses.

JAGUAR (*Panthera onca arizonensis*)

Status of the Species in the Action Area

Brown (1983) presented an analysis suggesting there was a resident breeding population of jaguars in the southwestern United States at least into the 20th century. The Service (USFWS 1990a) recognizes that the jaguar continues to occur in the American Southwest, at least as an occasional wanderer from Mexico. Goldman (1932) believed the jaguar was a regular, but not abundant, resident in southeastern Arizona. Hoffmeister (1986) considered the jaguar an uncommon resident species in Arizona. He concluded that the reports of jaguars between 1885 and 1965 indicated that a small but resident population once occurred in southeastern Arizona. Brown (1983) suggested that the jaguar in Arizona ranged widely throughout a variety of habitats from Sonoran desertscrub upward through subalpine conifer forest. Most of the records were from Madrean evergreen-woodland, shrub-invaded semidesert grassland, and along rivers.

The AGFD (1998) cited two recent reports of jaguars in Arizona. The individuals were regarded as transients from Mexico. One of the reports was from 1987 from an undisclosed location. The other report was from 1988, when tracks were observed for several days before the treeing of a jaguar by hounds in the Altar Valley, Pima County. An unconfirmed report of a jaguar at the Coronado National Memorial was made in 1991 (Ed Lopez, Coronado National Memorial, pers. comm., 1992 *in litt.* USFWS 1997c). In 1993, an unconfirmed sighting of a jaguar was reported for BANWR (William Kuvlesky, pers. comm., USFWS, *in litt.*, USFWS 1997c). Because regional jaguar sightings are rare, the probability of jaguars occurring within Fort Huachuca is low.

Effects of the Proposed Action

Although no confirmed sightings of a jaguar have occurred on Fort Huachuca, the availability of suitable jaguar habitat in the Huachuca Mountains suggests that the species may occur on the installation in the future if regional jaguar populations increase. Suitable habitat includes about 23,300 acres of oak-grass savanna, oak woodlands, mixed woodlands, mahogany woodlands, and conifer woodlands on the South and West Ranges. Proposed construction activities would not disturb these habitat types. Few operational activities take place in these areas; thus the potential for direct mortality would be limited to collisions with vehicles that infrequently travel these areas, or with recreational vehicles that use the canyons. Recreational activity is not permitted beyond the cantonment area at night, when jaguars are most active, so the overall risk of jaguars colliding with vehicles would be negligible.

Suitable habitat for the jaguar could potentially be affected by wildland fire, prescribed fire or managed natural fire. Such fires could result in loss of foraging or denning habitat. However, the Fort's commitment to fire prevention, prescribed burning, and fire suppression procedures outlined in Section 5 of the BA, particularly in wooded habitat, the potential for fire to adversely affect the jaguar and its habitat is reduced.

Conclusion

The Service concurs with the Fort's determination that the proposed action may affect, but is not likely to adversely affect the jaguar for the following reasons:

1. No jaguar has been recorded in the area and they are unlikely to occur for any length of time;

2. Suitable dispersal habitat may be present, but habitat for resident jaguars is minimal at best;

3. Dispersal habitat will be maintained; and

4. Expected levels of use and activity are not expected to discourage use of the area for jaguar movement.

LOACH MINNOW (*Tiaroga cobitis*)

Status of the Species in the Action Area

Historic range of the loach minnow included the basins of the Verde, Salt, San Pedro, San Francisco, and Gila rivers (Minckley 1973, Sublette et al. 1990). Loach minnow are not currently known from Fort Huachuca or the upper San Pedro River basin, however the species occurred in the river historically (Minckley 1973, U.S. BLM 1998). Within the San Pedro River watershed, the loach minnow is found in Aravaipa Creek and two tributaries to Aravaipa Creek: Deer Creek (Hell Hole) and Turkey Creek. Although the loach minnow is not present within the proposed action area, the recovery plan for the loach minnow (USFWS 1990b) recommends reestablishing this species within its historical range, including perennial reaches of the San Pedro and Babocomari Rivers.

Critical habitat was designated for loach minnow on March 8, 1994 (USFWS 1994a), but was set aside by order of the Federal courts in Catron County Board of Commissioners, New Mexico V. U.S. Fish and Wildlife Service, CIV No. 93-730 HB (D.N.M., Order of October 13, 1994). Critical habitat was subsequently revoked by the Service (USFWS1998). It was again designated on April 25, 2000 (USFWS 2000). Critical habitat includes portions of the Verde, Black, middle Gila, San Pedro, San Francisco, Tularosa, Blue, and upper Gila Rivers and Eagle, Bonita, Tonto, and Aravaipa Creeks and several tributaries of those streams.

Although the loach minnow is currently listed as threatened, the Service has found it warrants uplisting to endangered status. Reclassification is pending, as work is precluded due to work on higher priority listing actions (USFWS 1994b). The need for reclassification is not due to data on declines in the species itself, but is based upon increases in serious threats to a large portion of its habitat.

Effects of the Proposed Action

Effects of the proposed action on loach minnow are similar to those described for the spikedace, except that loach minnow is not currently suspected to occur in the lower San Pedro River. Thus, any possible effects would be to critical habitat; and as described for the spikedace, the only potential effects would be in the upper San Pedro River.

If unmitigated groundwater pumping by Fort Huachuca and other water users in the Sierra Vista subwatershed continues in excess of supply, it will eventually lead to de-watering of all or portions of the upper San Pedro River and loss of recovery habitat (see Huachuca water umbel section for detailed discussion). However, Fort Huachuca's groundwater use in the

subwatershed will not go unmitigated. Fort Huachuca will implement conservation measures to offset their contribution to groundwater overdraft in the upper San Pedro River basin by 2011. Also, Fort Huachuca will request that the communities and agencies within the Sierra Vista Subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well.

As discussed previously, without a concerted effort to balance the water budget or otherwise mitigate the impacts of groundwater pumping, de-watering and loss of riparian vegetation is possible on portions of the San Pedro River, to include the 37 miles of loach minnow critical habitat. The habitat north of Charleston, particularly near the Babocomari confluence, is most at risk, followed by the reach from Highway 90 to Charleston. Evidence suggests that de-watering is already occurring, although the cause is unclear and may or may not currently be attributable to effects of the action (ADWR 1994, ASL 1994, WESTEC 1996, Sharma et al. 1997, Fenske 1998, Koehler and Ball 1998, Pool et al. 1998, MacNish 1998, SAIC 1998b, San Pedro Expert Study Team 1999). Of particular concern is the potential for agricultural development near the river, which could result in de-watering the portion of critical habitat on the San Pedro River from Hereford to Highway 90.

However, most groundwater use in the Sierra Vista Subwatershed will not go unmitigated. Fort Huachuca will implement conservation measures to offset their contribution to groundwater overdraft in the upper San Pedro River basin by 2011. More important, Fort Huachuca will request that the communities and agencies within the Sierra Vista Subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well. In the near-term, successful implementation of the Sierra Vista effluent recharge project will assist in this effort and potentially mitigate near-term effects to river base flow.

Conclusion

The Service concurs with the Fort's determination that the proposed action may affect, but is not likely to adversely affect the loach minnow. We base this determination on the following:

1. The most important habitats and only populations of loach minnow in the San Pedro River watershed are in Aravaipa Creek, which would not be affected by groundwater pumping or other activities of Fort Huachuca.

2. Although the species does not currently occur in the upper San Pedro River, the proposed action threatens recovery habitat of the loach minnow in the river. Thus, our concurrence assumes implementation of the proposed conservation measures will mitigate effects to the river and preserve those recovery opportunities.

SPIKEDACE (*Meda fulgida*)

Status of the Species in the Action Area

Spikedace are a small silvery fish whose common name alludes to the well-developed spine in the dorsal fin (Minckley 1973). Spikedace historically occurred throughout the mid-elevations of the Gila River drainage, but is currently known only from Aravaipa Creek (Graham and Pinal Counties, Arizona), the upper Gila River (Grant and Catron Counties, New Mexico), the middle Gila River (Pinal County, Arizona), Eagle Creek (Greenlee County, Arizona), and the Verde River (Yavapai County, Arizona)(Barber and Minckley 1966, Minckley 1973, Anderson 1978, Barrett et al. 1985, Bestgen 1985, Marsh et al. 1990, Sublette et al. 1990, Jakle 1992, Knowles 1994). Habitat destruction, and competition and predation from introduced nonindigenous fish species are the primary causes of the species decline (Miller 1961, Williams et al. 1985, USFWS 1986, Douglas et al. 1994).

Critical habitat for the spikedace followed the same process as the loach minnow. The spikedace also is warranted for uplisting to endangered status for the same reasons as the loach minnow. Although spikedace is common in some portions of its highly reduced range, it is uncommon to rare in most. Presently, the species is common only in Aravaipa Creek and some parts of the upper Gila River in New Mexico. Populations in the Verde River and Eagle Creek have not been found since 1999 and 1987, respectively and their status is uncertain (AGFD unpublished data, Marsh et al. 1989, Rinne *in press*).

Spikedace are not currently known from Fort Huachuca or the upper San Pedro River basin (Sally Stefferud, Service, Phoenix, pers. comm. 1998); however, the species occurred in the upper San Pedro River historically (U.S. BLM 1998). Spikedace occur in Aravaipa Creek, in suitable habitat throughout the area of perennial flow (Barber and Minckley 1966, Minckley 1973, Velasco 1994). For several years spikedace were thought to be extirpated in the San Pedro and middle Gila River (between Coolidge and Ashurst-Hayden Dams) systems with the exception of Aravaipa Creek. However in 1991, a single spikedace was collected in the Gila River near Florence (Jakle 1992), suggesting the species may occur elsewhere on the Gila and lower San Pedro Rivers downstream of the Aravaipa confluence.

In Aravaipa Creek there are a number of threats to the spikedace and its habitat. Aravaipa Creek and its watershed have been subjected to substantial human uses since the settlement of the area by Europeans. The watershed, like many in the desert southwest, has been altered by grazing, mining, timber harvest, water development, irrigated agriculture, roads, recreation, and other human uses (Minckley 1981, Bahre 1991). These uses have altered runoff, sediment transport, and groundwater recharge patterns within the basin and may have caused changes in the perennial flow of Aravaipa Creek. Minckley (1981) reports that comparisons of recent and 80 to 120 year-old accounts and photographs reveal that the dry incised stream channel near Klondyke was historically a marshy area of perennial water. He also reports that riparian forests were more massive in size and development with a larger component of younger trees, and that common reed, *Phragmites australis*, first noted by Bell in 1869 (as cited in Minckley 1981), has been eliminated from Aravaipa Creek.

Although Aravaipa Creek presently supports fewer nonindigenous species than many of Arizona's streams, the number and distribution of nonindigenous species is increasing. In 1981, four nonindigenous fishes were known from the watershed and only two of those were recorded from Aravaipa Creek itself (Minckley 1981). By 1992, eight nonindigenous fishes were known from Aravaipa Creek and at least four of those were thought to be reproducing in the creek (Velasco 1994). The remaining four were thought to originate from movement out of ponds, stock tanks, and the San Pedro River. Green sunfish, largemouth bass, and yellow and black bullhead are all predatory species that consume spikedace. Red shiner is thought to be highly detrimental to small native cyprinids, such as spikedace through competition and predation (Bestgen 1986, Marsh et al. 1989, Rinne 1991). Although red shiner invaded the entire perennial length of Aravaipa Creek in 1990-91, they did not establish a population and have only been found once since, in lower Aravaipa Creek in October 1993 (Bettaso 1993).

When spikedace populations are at low levels, they can be very difficult to locate. Fish sampling data from the lower San Pedro and middle Gila Rivers is limited and localized. Perennial flows in the Gila River, perennial and ephemeral flows that connect reaches of the San Pedro River with the Gila River and Aravaipa Creek, and the spikedace record at Cochran Crossing suggest that a small number of spikedace may be present on the lower San Pedro River from the Aravaipa confluence to Dudleyville, and possibly downstream on the middle Gila River. Based on findings for other native fish in these reaches, numbers of spikedace may increase temporarily in this area following flood events.

Although the species is currently thought to be extirpated, the upper San Pedro River is considered important recovery habitat for the spikedace. A number of agencies have been working toward native fish recovery in the San Pedro River. The BLM's management plan for the SPRNCA calls for "reintroduction of native wildlife species, including threatened and endangered species, as well as for consideration of "removal of exotic fish from existing ponds (U.S. BLM 1989). BLM's habitat management plan for the area contains specific objectives for reestablishing spikedace. Funding is available through the Bureau of Reclamation as a result of the Central Arizona Project jeopardy biological opinion to remove nonindigenous fish from Kingfisher or Young-Block ponds near the Highway 90 crossing, as well as other measures needed to reduce nonindigenous species and reestablish native fishes into the SPRNCA.

Effects of the Proposed Action

The Fort's proposed action does not include activities on Aravaipa Creek or at other spikedace localities, thus no direct effects would occur. However, as discussed in the Effects of the Proposed Action for the southwestern willow flycatcher, the upper and lower reaches of the San Pedro River are hydrologically connected, so that effects in the upper basin could potentially affect flows and riparian habitat in the lower basin. If groundwater pumping attributable to the Fort caused a reduction in flows on the lower San Pedro River, the spikedace could potentially be adversely affected. This possibility was examined in the Effects of the Proposed Action for the flycatcher. In that discussion, we concluded that groundwater pumping in the upper basin would not significantly affect flows in the lower basin for the following reasons: 1) flood flows

are not affected by groundwater pumping, 2) the water budget prepared by ADWR (1991) estimates that no groundwater inflow occurs into the Benson subwatershed from the Sierra Vista subwatershed, 3) conservation measures included in the proposed action will minimize affects to groundwater in the Sierra Vista subwatershed; and 4) groundwater inflow across subwatershed boundaries in the lower San Pedro River is also insignificant (ADWR 1991).

Groundwater flow between subwatersheds might be greater if water use did not exceed water supply in the Sierra Vista subwatershed, but because of the presence of cones of depression it is unlikely that any increased water supply would result in significant increases in subwatershed outflow. Even if the entire deficit (5,141 acre feet) was discharged as outflow from the subwatershed, this would only account for about15 percent of the water supply in the Benson subwatershed. How much of this outflow might reach the river downstream of the Aravaipa confluence where spikedace are most likely to occur is unknown. The reach downstream of the Aravaipa confluence is in the Winkelman subwatershed immediately upstream of the Gila confluence. Annual water supply to the Winkelman subwatershed is 73,760 acre-feet, of which only 150 acre-feet is groundwater inflow from upstream (ADWR 1991). Although the effects of groundwater pumping in the Sierra Vista subwatershed on potential downstream spikedace habitat are uncertain, the best information available suggests that currently these effects are probably small or negligible. Effects of future groundwater pumping are predicted to be insignificant because base flow into the subwatershed where spikedace may occur is very small.

As discussed for the Huachuca water umbel and the southwestern willow flycatcher, if unmitigated groundwater pumping by Fort Huachuca and other water users in the Sierra Vista subwatershed is in excess of supply, it will eventually lead to de-watering of all or portions of the upper San Pedro River and loss of recovery habitat and opportunities for the spikedace (see Huachuca water umbel section for detailed discussion). However, groundwater use attributable to Fort Huachuca in the subwatershed will not go unmitigated. Fort Huachuca will also request that the communities and agencies within the Sierra Vista Subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well. It is expected that implementation of Fort Huachuca water conservation measures will be successful in minimizing potential adverse effects to the river and spikedace recovery habitat. If regional water resources planning and implementation efforts occur, effects from groundwater use in the Sierra Vista subwatershed should be almost fully mitigated.

As discussed previously, without a concerted effort to balance the water budget or otherwise mitigate the impacts of groundwater pumping, de-watering and loss of riparian vegetation is possible on portions of the San Pedro River, to include the 37 miles of spikedace critical habitat. The habitat north of Charleston, particularly near the Babocomari confluence, is most at risk, followed by the reach from Highway 90 to Charleston. Evidence suggests that de-watering is already occurring, although the cause is unclear and may or may not currently be attributable to effects of the action (ADWR 1994, ASL 1994, WESTEC 1996, Sharma et al. 1997, Fenske 1998, Koehler and Ball 1998, Pool et al. 1998, MacNish 1998, SAIC 1998b, San Pedro Expert Study Team 1999). Of particular concern is the potential for agricultural development near the

river, which could result in de-watering the portion of critical habitat on the San Pedro River from Hereford to Highway 90.

Wildfires ignited by recreational users or ordnance, prescribed fire, and fire suppression activities could result in direct effects to spikedace critical habitat. Indirect effects could also occur from these activities, particularly as a result of watershed degradation and subsequent erosion, sedimentation, and changes in stream hydrology. Wildfire on the East Range could escape fire suppression measures and spread into the SPRNCA; however, the probability of this occurring is low. Fires started on the East Range are infrequent and there are no records of fires spreading to the SPRNCA. In addition, if a fire did start in the East Range, it would not likely spread far because of low fuel loads.

Erosion within the East Range is the highest on the installation, with sheet and rill erosion in the central part of the range the most significant. Through analysis and field observation, the majority of sediment from areas within the central zone of the East Range is deposited within the respective stream channels on the installation (ENRD 1997). These findings suggest that, while significant erosion and sediment transfer continue to occur across the East Range, the extent of deposition is predominantly limited to areas within Fort Huachuca and not in the SPRNCA.

Conclusion

The Service concurs with the Fort's finding that the proposed action may affect, but is not likely to adversely affect the spikedace. We base this finding on the following:

1. The most important habitats and most significant population of spikedace in the San Pedro River watershed are in Aravaipa Creek, which should not be affected by groundwater pumping or other activities in the proposed action.

2. With prompt development and implementation of groundwater management measures, as proposed by Fort Huachuca, groundwater pumping attributable to the proposed action is unlikely to have significant effects on flows in the lower San Pedro River.

3. Erosion and fire are unlikely to reach the San Pedro River and designated critical habitat.

Although the species does not currently occur in the San Pedro River, the proposed action could threaten recovery habitat of the spikedace in the river. Thus, our concurrence assumes implementation of the proposed action, and especially the conservation measures, both on-post and regionally, should remove threats to spikedace recovery habitat.

APPENDIX 2. PREVIOUS CONSULTATIONS

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-98-F-266	2/22/2002	Fort Huachuca programmatic biological opinion		Service reviewed annual report for 2001 and found that it meets the requirements of the biological opinion.
2-21-98-F-266	1/25/2002	Fort Huachuca programmatic biological opinion - purchase of conservation easements		Service concurred with credits for reduction in water use with the purchase of a conservation easement and with the method used to determine the water savings and credit.
CL 11-0030	11/14/2001	Fort Huachuca Integrated Natural Resources Management Plan	HWU, SWWF, MSO, LLNB, STS, spikedace, loach minnow, Canelo Hills ladies'-tresses and designated critical habitat	The Service commented on the INRMP.
2-21-96-I-032 2-21-98-F-266	7/24/2001	Integrated Natural Resources Management Plan and Environmental Assessment		Comments on second draft .

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-01-I-422	9/13/2001	Electronic proving ground		Species list request from EEC
2-21-01-I-413 CL2001637	8/24/2001	Wind data towers	bald eagle, LLNB	Concurrence with may affect, not likely to adversely affect
2-21-98-F-266R4	5/9/2001	Garden Canyon Road maintenance project	HWU, MSO	Concurrence with may affect, not likely to adversely affect
2-21-01-I-237	4/12/2001	Sites formerly used for disposal of explosive wastes		Species list
2-21-98-F-266	4/20/2001	Easements - Fort Huachuca programmatic biological opinion		Discuss priorities for the acquisition of easements.
2-21-98-F-266R3	4/17/2001	grassland fire research project	LLNB	Concurrence with may affect, not likely to adversely affect.
2-21-01-I-192	3/15/2001	grassland fire research project	LLNB	Concurrence with may affect, not likely to adversely affect.

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-01-I-338	7/11/2001	NPDES permit for Fort Huachuca wastewater treatment plant and groundwater recharge basins - Arizona Department of Environmental Quality	MSO	Concurrence with may affect, not likely to adversely affect.
2-21-95-I-421	12/8/2000	Airport 203 acre land transfer	HWU, SWWF, LLNB, bald eagle, spikedace and loach minnow and designated critical habitat	The Service concurred with effect determinations.
2-21-98-F-266R2	29 Nov 2000	East Range effluent reuse program	HWU, SWWF, MSO, LLNB, STS, spikedace, loach minnow and Canelo Hills ladies'-tresses	No jeopardy and concurrence.
2-21-01-I-016	11/7/2000	Electro-optical sensor testing near Fort Huachuca, Department of the Navy	LLNB, bald eagle, MSO, northern aplomado falcon, SWWF, whooping crane	Concurrence with may affect, not likely to adversely affect.

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-98-F-266R1	9/29/2000	UAV Program expansion and critical habitat designated for the spikedace and loach minnow	HWU, SWWF, MSO, LLNB, STS, Canelo Hills ladies'-tresses, spikedace and loach minnow	No jeopardy and concurrence.
2-21-00-I -345	7/28/2000	Wind turbine at Fort Huachuca	LLNB, bald eagle	Concurrence with may affect, not likely to adversely affect.
2-21-00-I-183	7/3/2000	Veteran's Cemetery	LLNB, HWU, SWWF, loach minnow, spikedace	Concurrence with may affect, not likely to adversely affect.
2-21-00-I-259	5/17/2000	Unmanned aerial vehicle program at Fort Huachuca		Species list request from EEC.
2-21-00-I-260	5/17/2000	Fort Huachuca groundwater recharge facility		Species list request from CH2MHILL.
2-21-98-F-266	3/20/2000	Easements-programmatic biological opinion		Discussed potential acquisition of conservation easements on three parcels in the "gap".

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-00-I-183	2/29/2000	Fort Huachuca deeding 130 acres to State of Arizona for Veterans Cemetery		Service concurred with no affect.
98266	10/27/1999	Us Army Intelligence Center & Fort Huachuca Activities near Fort Huachuca through 2008	HWU, SWWF, MSO, LLNB, STS, spikedace, loach minnow, Canelo Hills ladies-tresses	Formal consultation on programmatic activities - no jeopardy.
2-21-98-I-310	6/16/1998	Fire management activities on South Range	LLNB	Service concurred with may affect, but is not likely affect.
2-21-98-I-291	6/1/1998	Environmental resources survey of Army Reserve sites of the 63rd Division at Fort Huachuca		Species list
2-21-98-I-134	1/28/1998	Fort Huachuca live land mines		

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-96-I-147	1/8/1998	Programmatic - all activities	MSO, peregrine falcon, SWWF, LLNB, STS, HWU, Canelo Hills ladies'-tresses	Service requested that Army initiate formal consultation.
2-21-96-I-1470	10/8/1997	Programmatic - all activities	Same as above	Service provided comments on draft Biological assessment.
2-21-96-I-127	8/18/1997	AZ Army National Guard activities at Fort Huachuca	same as above plus jaguar, ocelot, jaguarundi, Mexican gray wolf, CFPO	Service provided comments to Guard on the Dec 1996 draft biological assessment.
No number	7/14/1997	AZ Army National Guard activities at Fort Huachuca	not specified	Service requested environmental assessment and mitigation of Guard activities at Fort Huachuca and elsewhere.
2-21-96-I-127	no date	AZ Army National Guard Activities at Fort Huachuca	MSO, peregrine falcon, SWWF, LLNB, STS, HWU, Canelo Hills ladies'-tresses, CFPO, spikedace, others	Draft biological assessment on Guard activities.

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-96-I-127	6/9/1997	AZ Army National Guard activities at Fort Huachuca	not specified	Service requested updated consultation schedule.
2-21-97-I-196	2/4/1997	Regionalization of civilian personnel administrative functions	MSO, peregrine falcon, SWWF, CFPO, bald eagle, LLNB, spikedace, STS, HWU, ocelot, Canelo Hills ladies'-tresses, Mexican gray wolf, jaguarundi, jaguar, Gila topminnow	Service concurred with no affect.
2-21-97-I-010	10/10/1996	Fort Huachuca DOA Realignment of 14 Western Civilian Personnel Office Operations into one Regional Office		Species list.
2-21-96-I-370	8/12/1996	Lists for U.S. Army Reserve Installations in Tucson and Fort Huachuca - COE		Species list

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-96-I-147	6/18/1996	Preliminary draft Master Plan EIS	same as above plus Chiricahua dock	Service provided comments on preliminary draft EIS.
2-21-96-I-122	5/31/1996	Draft EA for Base Realignment and Closure 1995 - Information Systems Engineering Command to Fort Huachuca/ Downsizing Personnel Actions at Ft Huachuca Army Intelligence Center	LLNB, MSO, STS, SWWF, HWU	Service concurred with No Affect determination.
2-21-96-I-032	4/12/1996	Preliminary Draft Integrated Natural Resources Management Plan for Fort Huachuca	SWWF, HWU, loach minnow, spikedace	
2-21-96-I-188	3/5/1996	Environmental Assessment for Recreational Vehicle Center on Fort Huachuca	MSO, LLNB, HWU	

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-96-I-142	2/13/1996	J-STARS EA	MSO, HWU STS	Service did not concur with no affect.
2-21-94-I-473	9/22/1995	Programmatic consultation on draft Master Plan EIS	HWU, San Pedro species	Service suggested measures for mitigating possible adverse effects to San Pedro species.
2-21-94-I-473	6/21/1995	Endangered species issues at the Fort	SWWF, HWU, spikedace, loach minnow, razorback sucker, desert pupfish, LLNB, MSO, peregrine falcon	Service comments on endangered species, especially in regard to San Pedro River.
2-21-95-I-087	12/21/1994	Sensitive species management Plan for the Fort	Aplomado falcon, San Pedro species	Service forwarded a species list to Fort and commented on concerns in regards to listed species.
2-21-94-I-609	10/13/1994	EA for M1 tank operation	MSO	Service commented on draft EA.
2-21-94-I-473	9/14/1994	Possible base realignment	All listed species in the area	Service provided Fort's consultant with species list.
2-21-94-I-527	9/6/1994	Fort Huachuca notice of intent to conduct Environmental Impact Statement		Species list

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Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-94-I-473	8/22/1994	Possible base realignment	All listed species in the area	Service provided Fort's consultant with species list.
2-21-94-I-321	4/21/1994	Tucson Sunrise Rotary club equestrian trail ride, Huachuca Mtns, South Range training area		Species list
2-21-94-I-231	3/2/1994	Upgrade airfield pavement, repair of Libby Army Air Field runway		Species list
no number	2/25/1994	8th of the 40th tank training	LLNB	Service conditionally concurred with no effect determination.
2-21-92-I-146	1/4/1994	Proposed gas station and mini-mall	none	Service determined no listed species were in project area.
no number	12/28/1993	M1 tank maneuvers/firing	MSO	Service expressed concerns over possible adverse effects to spotted owls.
no number	12/17/1993	draft EA M1 tank operations	MSO, LLNB	Service commented on draft EA.
2-21-94-I-054	12/3/1993	EA for renovation of Greely Hall	none	Service concurred with no affect.

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Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-94-I-116	12/22/1993	Normal maintenance and repair of real property, minor construction		Species list
2-21-93-I-456	8/6/1993	Demolition of buildings		Species list
2-21-93-I-211	6/2/1993	AEROSTAT improvement project		Species list
no number	5/7/1993	EA for restricted airspace over South Range	LLNB, MSO	Service found that no additional effects to listed species would occur.
no number	4/1/1993	EA for comprehensive unmanned air vehicle	LLNB, MSO	Service provided comments on draft EA
no number	11/4/1992	EA for Applied Instructional Building for UAVs	not specified	Service provided comments on draft EA.
2-21-92-I-742	10/2/1992	EA for renewal of leases at Willcox Playa and Sands Ranch	LLNB	Service concurred with no affect.
2-21-92-I-743	9/28/1992	Demolition of World War II buildings		Species list

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
no number	8/24/1992	EA for Applied Instructional Building for UAVs	not specified	Service provided comments on draft EA.
no number	8/11/1992	Comprehensive EIS on Fort Huachuca activities and missions	LLNB, MSO	Service commented on need for comprehensive EIS and biological assessment.
no number	6/2/1992	EA for Asbestos Management Plan	LLNB	Service concurred with No effect.
2-21-92-I-750	4/14/1992	EA for 79 Army Security Agency (ASA) points near and on the Fort	LLNB	Service provided comments on draft EA .
no number	3/19/1992	Draft FONSI for Vehicle Magnetic Signature Duplicator test	none specified	Service found that no listed species would be affected.
2-21-92-I-153	3/12/1992	EA for Test & Experimental Command, Unmanned Air Vehicle-Short Range	LLNB	Service provided comments on draft EA.

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-90-I-257	3/10/1992	Request to extend the UAV-SR Program to June 30, 1992	LLNB	Service did not object to time extension.
no number	2/26/1992	EA for continuation of Joint Terminal Information Distribution System (JTIDS)	none specified	Service provided comments on draft EA.
no number	2/11/1992	Advanced Airlift Tactics Training Center	LLNB	Service provided comments on mitigation measures.
no number	12/17/1991	Dec 1991 and Jan 1992 test of the JTIDS	none specified	Service found that no listed or proposed species would be affected.
2-21-92-I-193	1/7/1992	Proposed expansion of Black Tower UAV compound	none specified	Service provided comments on project.
2-21-92-I-143	12/12/1991	Electronic Proving Grounds Fort Huachuca Unmanned Aerial Vehicle	LLNB	Species list
2-21-92-I-146	12/12/1991	Fort Huachuca Base Realignment	LLNB, MSO	Service provided a species list.

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
no number	12/2/1991	draft EA for Development of Forward Operating Base for the Advanced Airlift Tactics Training Center, Joint Operations Training Site	LLNB	Service provided comments on draft EA.
no number	12/2/1991	draft FONSI for TEXCOM test of TOPHUNTER tactical communication Intelligence direction finding system	LLNB	Service provided comments on the draft FONSI.
no number	12/2/1991	EA for Electronic Proving Ground JTIDS on 24 sites within 40 mi of Fort	LLNB	Service provided comments on draft EA.
2-21-92-I-038	11/21/1991	11th Signal Brigade Training Exercise	LLNB	Service concurred with no affect.
2-21-92-I-053	11/8/1991	UAV tests by TEXCOM	LLNB, peregrine falcon, gila topminnow, MSO	Service provided a species list for the subject project.

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-91-I-534 2-21-91-I-442	10/2/1991	Exercises of the 11th Signal Brigade	none specified	Service found that consultation on individual exercises is not necessary under specified conditions.
no number	9/23/1991	EA for Fire Department Training Academy	LLNB	Service found that the action would have no affect.
no number	9/23/1991	UAV projects	LLNB	Service commented on the need for comprehensive effects assessment.
2-21-91-I-534	9/20/1991	EA for 11th Signal Brigade Exercises, Nov 1991	none specified	Service concurred with no affect.
2-21-90-I-257	9/6/1991	UAVs	LLNB	Service conditionally concurred with not likely to adversely affect.
2-21-91-I-477	8/27/1991	EAs for renewal of leases at Willcox Playa and near Gila Bend	Whooping crane, Tumamoc globeberry, LLNB	Service concurred with no affect.
no number	7/9/1991	8th of the 40th Army Reserve Unit Training, fires in agave areas	LLNB	Service commented on issues involving listed species and discussed need for a comprehensive consultation on all activities.

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
no number	1991	8th of the 40th Army Reserve activities	none specified	Compliance of the 8th of the 40th with conditions/environmental regulations.
2-21-90-I-257	5/30/1991	UAV activities over Canelo Hills And Patagonia Mountains	LLNB	Service conditionally concurred with no effect.
2-21-91-I-207	3/19/1991	Prescribed fire on Area W	LLNB	Service provided comments on proposed fire and identified a need for a comprehensive Fire Management plan.
2-21-91-F-083	1/18/1991	Prescribed fire and fire breaks on South Range	LLNB	Biological opinion, in which the Service found no jeopardy.
2-21-91-F-083	12/18/1990	Prescribed fire and fire breaks on South Range	none specified	Service acknowledged receipt of request for formal consultation.
2-21-91-I-041	11/14/1990	Tank firing at Fort Huachuca	LLNB, peregrine falcon	Service provided species list for project area.
no number	6/4/1990	EA for UAV runway	LLNB	Service concurred with no affect.
no number	5/23/1990	Base realignment	LLNB	Service concurred with no affect.
no number	3/27/1990	UAV runway	LLNB	Service provided comments on first draft EA.
no number	3/20/1990	NEPA, ESA issues, prescribed fire	LLNB	Service provided comments on NEPA and ESA processes.

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Consultation #	Date of Correspondence	Project	Species Addressed	Findings
no number	12/21/1989	EA/scoping letter for High Frequency Test Facility at Site Sibil	LLNB	Service comments on draft EA/scoping letter.
no number	9/11/1989	Relocation of High Frequency Radio Transmitter from Blacktail Canyon to Site Sybil	peregrine falcon, LLNB	Service requested an opportunity to comment on Draft EA.
no number	9/24/1989	EA for High Frequency Test Facility	LLNB	Service comments on draft EA.
2-21-90-I-115	3/15/1990	Military Use Sites	LLNB, peregrine falcon, Sonoran pronghorn, Tumamoc globeberry	Species list
no number	3/15/1990	EA for Base Realignment	LLNB	Service commented on draft EA and stated that section 7 consultation may be required.
no number	8/29/1989	EA for UAV	none specified	Service concurred with the Fort's FONSI.
no number	7/13/1989	Effects of fire and training	LLNB	Service commented on recent fires, and need for a comprehensive evaluation of effects of military activities at Fort Huachuca

James A. Marks, Brigadier General, U.S. Army

Appendix 2. Previous consultations on activities at or near Fort Huachuca, Arizona, by the Army or other Federal agencies.

Consultation #	Date of Correspondence	Project	Species Addressed	Findings
2-21-89-I-139	6/13/1989	Fort Huachuca Burn Program	LLNB	Species list
2-21-89-I-117	6/1/1989	Buffalo Soldier Trail Sierra Vista	LLNB	Species list
2-21-89-I-098	5/8/1989	Sierra Vista Airport Expansion	LLNB	Species list
no number	11/23/1988	NEPA and ESA processes	LLNB	Service identified a need for better coordination between Fort and Service on NEPA and ESA issues.
2-21-86-I-044	2/19/1986	AEROSTAT project		Formal consultation - no jeopardy

Species: SWWF = southwestern willow flycatcher; LLNB = lesser long-nosed bat; MSO = MSO
CFPO = cactus ferruginous pygmy-owl; STS = Sonora tiger salamander; HWU = Huachuca water umbel

James A. Marks, Brigadier General, U.S. Army
2-21-02-F-229
(2-21-98-F-266)

BIOLOGICAL OPINION SUMMARY
Effects of proposed programs at Fort Huachuca,
Cochise County, Arizona

Date of opinion: August 23, 2002

Project: Land use, ongoing and planned training activities, construction activities, administrative and support actions, recreation, fire management, and other activities proposed by the Army at Fort Huachuca and adjacent areas for a 10-year period from the date of this opinion. The Fort proposed numerous conservation measures as part of the proposed action. Included in the conservation measures were actions to address water use that will conserve 3,077 acre feet of groundwater. This represents about 60 percent of the groundwater deficit in the Sierra Vista subwatershed.

Location: Cochise County, Arizona

Listed species affected: endangered southwestern willow flycatcher (*Empidonax traillii extimus*), endangered Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*) with designated critical habitat, endangered Sonora tiger salamander (*Ambystoma tigrinum stebbinsi*), endangered lesser long-nosed bat *(Leptonycteris curasoae yerbabuenae*), threatened Mexican spotted owl (*Strix occidentalis lucida*) with designated critical habitat.

Biological and conference opinion: No Jeopardy and no destruction or adverse modification of proposed critical habitat

Incidental take statement:

Anticipated take: *Exceeding this level may require reinitiation of formal consultation.*

The Service anticipates incidental take may occur for the Mexican spotted owl, Sonora tiger salamander, and lesser long-nosed bat.

Conservation recommendations: *Implementation of conservation recommendations is discretionary.*

Multiple conservation recommendations to further the conservation and recovery of the species and implement the appropriate recovery plans for each species.